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THE THEORY AND PRACTICE OF SCIENTIFIC MANAGEMENT

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TO THE HONORED MEMORY

OF

FREDERICK WINSLOW TAYLOR

PREFACE

An element of risk attaches to any effort to appraise a movement while that movement is still in its earlier and more enthusiastic stages, especially when the appraisal is made by one who is (however modestly) a participant in it. The attempt is justified only by the accuracy with which facts are presented and by the justice and fairness of the inferences and conclusions drawn. In this book I have tried to give only facts which can be verified and to make inferences with all due conservatism. The result is offered for what it may be worth. There is some consolation in the thought that a later generation may count it an original, or at least contemporary, source.

Owing to the nature of the investigations I have had to make in the preparation of this book, it is practically impossible to list the many friends and acquaintances to whom acknowledgments are due. First of all, I am indebted to the late F. W. Taylor, himself, for invaluable information, suggestions, and assistance, and to his group of followers, who have aided me in many ways and with whom I have

gained much of the practical experience, without which this book would have been written, if at all, from a quite different angle.

Acknowledgment is due, moreover, to the many owners and managers who have kindly given permission to study their plants, and to them and to many employees for detailed information.

I am also indebted to Dean E. F. Gay, of the Graduate School of Business Administration, Harvard University, for stimulating criticisms of this work in its early stages, and to Messrs. E. G. Mears and H. H. Farquhar, former students of mine, for help on the almost interminable bibliography.

Much of this book has already been published as a series of articles in the *Quarterly Journal of Economics*, and I am indebted to the editors of that journal for permission to use them again in their present form. For publication in this book they have been revised and brought up to date as fully as the exigencies of a busy professional life have permitted.

C. B. T.

CONTENTS

THE THEORY AND PRACTICE OF SCIENTIFIC MANAGEMENT

I

WHAT SCIENTIFIC MANAGEMENT IS

Any discussion of the theory and practice of scientific or positive management is confronted at the outset with the question, What is scientific management?

The development of the factory system brought with it many new problems connected with the organization and management of labor, the structure and equipment of factories, and the technique of production. By successful manufacturers these problems have always been solved in a way to make manufacturing at a profit possible. Early solutions, however, were necessarily crude and roughshod. With the enormous increase in demand for manufactured products, in the investment of capital, and in the number of men engaged in the business, with the consequent development of ever-keener competition, the early methods have been found insufficient. Especially within the

last twenty years a degree of skill and technical training has been brought to bear upon the solution of factory problems which has made modern factory management a thing much more elaborate, refined, and effective than ever before. A series of improvements in administration and methods have been made by many engineers and managers, and not a few of them have been developed by a method which might truly be called "scientific." Where, then, can we draw the line between modern management in general and what has come to be known technically as "scientific management"?

Out of the mass of engineers and managers who are responsible for present-day methods, there has grown a group originating with Mr. Frederick W. Taylor, of Philadelphia, who have perceived certain principles underlying the practices of management hitherto unrelated and uncoördinated. A collation of isolated successful experiments in various details of factory administration and methods has apparently shown a possibility of classification and generalization. Such classification and generalization are the basis for the development of a science, and the term "scientific management" is applied generally to the body of principles deduced from experience by Mr. Taylor, and the

engineers associated with and trained by him, and to the methods by which the resultant principles are applied to industry. "Scientific management," therefore, is distinctively scientific, since it aims to correlate and systematize all the best of modern developments in factory administration, and to push development further in accordance with the principles discovered.[1]

On the basis of this definition it is not difficult to segregate that portion of modern factory management which constitutes scientific management from that other portion which includes the many unrelated improvements, methods, and principles which are continually being evolved. Scientific management as such is that which has been developed and practiced by those who approach the subject in a scientific manner. Of these Mr. Taylor was the acknowledged pioneer and leader both in practice and theory.

Scientific management has been variously referred to as a new form of industrial organization, a new type of administration, a new

[1] Mr. Charles B. Going has published an article ("The Efficiency Movement — An Outline," *Transactions*, The Efficiency Society, vol. I, p. 11), showing the place of scientific management in the modern developments of factory organization and pointing out the common element in many movements.

"system." Again it is said to be a science, an art, a set of laws, principles, rules, methods, and processes, a policy, or even a set of forms and mechanisms. Its significance depends upon which of these things it is.

Industrial organization is the definition, correlation, and coördination of parts and functions in a group of elements made up of land and buildings, capital and credit, equipment and men, adapted to attain the important ends of economic manufacture, sale at a profit, and growth at least to the point where the effect of increasing difficulties of management counterbalances the possible advantages of further expansion. System is the mechanism whereby organization performs its functions of administration. Administration is the dynamics of organization. It is the injection of initiative, stimulus, and control into the static system of which organization is a cross-section. Rules, methods, and processes are names of varying degrees of inclusiveness for the prescribed procedures in the accomplishment of circumscribed and isolated results. A policy is a generalized rule determined empirically by a process of trial and error rather than by a scientific method of investigation.

Under these definitions, and in the light of

observation of the movement in practice, it is apparent that scientific management is a type of industrial organization and administration with a fairly definite system of its own and involves the use of rules, methods, and processes and, to some extent, of policies, just the same as any other type of management. What, then, is to differentiate it from others?

Scientific management in its best manifestations may be distinguished from other types of management in that it proceeds on *industrial principles*, which may be defined as *generalized rules of conduct based on law, recognized or as yet undiscovered, and useful to the attainment of important industrial ends, such as maximum output, low cost, high wages, equitable distribution, reduction of unemployment, industrial peace.* If we define a *law* as *a summary statement of fact or a description of a tendency common to a class of things*, then an *industrial law* is *any law, physical, chemical, biological, psychological, economic, or social, which is or may be a factor in industrial management.* The test by which scientific management determines whether any law is an industrial law, is the effect of that law on economy of production or conservation of energy, human or material.

What makes a type of management scientific,

then, is the fact that it rests on laws and principles rather than on policies. To be sure, until all the laws and principles of management are ascertained, it still remains true that policy must play a large part and that to that extent management remains at least partially an art; but the intention and the conscious effort to reduce the field of policy and to enlarge that of principle and law justly entitle any system which holds to it consistently to the name of scientific management.

Thus far there has been no uniformity in the attempts to classify and state these laws and principles. Mr. Taylor's own statements of what he refers to at different times as "principles," "elements," and "new duties" vary.[1]

Without attempting to state fully the laws and principles on which scientific management is based, it may be well to attempt at least to classify them. The following schema indicates the *laws* grouped under the "Science of Industrial Conservation" and the *principles* under the "Principles of Industrial Organization." This distinction between the science on the one hand and the principles on the other has important

[1] For an interesting attempt at systematic statement, see an article by Lieutenant G. J. Meyers, *Journal of American Society of Naval Engineers*, vol. 23, p. 994, reprinted in C. Bertrand Thompson's *Scientific Management*, p. 132.

practical bearings, particularly on disputed questions regarding the relation of scientific management to the labor problem.

The content of scientific management may be indicated schematically in this way: —

- I. Science of Industrial Conservation
  - A. Physical Laws
    - 1. Materials
    - 2. Equipment
    - 3. Processes
  - B. Psychophysical Laws
    - 1. Effort
    - 2. Habit
    - 3. Incentive
- II. Principles of Industrial Organization
  - A. Group
    - 1. Reliance on Law and Principle
    - 2. Functionalization
    - 3. Balance — Co-ordination ("exception principle")
    - 4. Harmony — Discipline
  - B. Individual
    - 1. Selection
    - 2. Training
    - 3. Specialization
    - 4. Control
    - 5. Stimulation
    - 6. Reward

As a study of this schema indicates, the laws of scientific management are, first, the physical and chemical laws covering materials, equipment, and processes, and, second, the psychological laws (undoubtedly operative no matter

how dimly understood) which govern the individual conduct and reactions of the human beings involved. The principles of scientific management are those which govern the relations of individuals to each other in organized groups and the methods of procedure by which scientific management is made effective in practice. The Science of Industrial Conservation, then, is based on natural laws; and natural laws, if accurately determined, are fixed and inflexible. They cannot be altered by a majority of votes. This is the important distinction between the Science of Industrial Conservation and the Principles of Industrial Organization. Principles, if they are, as defined, rules of conduct, may be changed and in fact are constantly subject to modification by consent and agreement.

The science of industrial conservation is based on physical laws so far as they apply to the materials, equipment (including machines and small tools), and processes involved in industries. Mr. Taylor's work on the composition of tool steel and the proper technical conditions for securing the maximum output from cutting tools, as illustrated in his *Art of Cutting Metals*, is an example.

The whole field of natural science is at the disposal of industry so far as industry wishes to utilize it. The participation of human beings suggests the resort to the vaguer and less definite group of psychophysical sciences. Scientific management has at least begun to investigate the laws of effort both mental and physical (as in the study of fatigue), and has even gone farther into the much more complex field of incentive as illustrated in the effort to determine the amount of bonus necessary to secure the workman's coöperation in the performance of a task. Scientific management is eminently "practical," and has been somewhat timid about applying the results of modern psychological and physiological study. This timidity will disappear, however, as psychology and physiology pass beyond the stage of laboratory experiment into experimentation under industrial conditions. There is here an excellent opportunity for fruitful coöperation between the scientist and the manager, as suggested and illustrated by H. Münsterberg in his book *Psychology and Industrial Efficiency.*

The principles of industrial organization may be divided into those which deal with groups of men and those which are concerned with individuals. The former refer to the relations of

all the individuals in an organization. The distinctive features which the Taylor System has added to the already current practice are those of reliance on law and principle, functional foremanship, the "exception principle" intended to aid in securing proper balance and coördination of men, and the principle of discipline (inherent but heretofore not formally expressed) for the conscious purpose of securing harmony rather than mere upholding of authority. This conception of self-enforced and fundamental discipline has led to the revolutionary result that the "men" themselves are as insistent on the performance of managerial duties by their "superiors" as their "bosses" formerly were on the men's "recognition" of their "authority."

In its dealings with individuals scientific management lays special stress on the principles of selection to fit the job, individual training for their better accomplishment, an extension of specialization to the utmost limit which the size of the industry permits, definite and positive control over all processes and operations, and the predetermined and conscious stimulation of the men to the greatest degree of exertion consistent with their continued health by means of a special reward in

the form of a "bonus," a "premium," or a "high rate" for superior accomplishment.

From this classification it will be observed that the most distinctive contribution of scientific management has been in the field of principles rather than in that of laws. The determination of laws is a long and usually unlucrative process better carried on by "pure scientists" in their laboratories for the benefit of all possible users than by individual managers restricted by a multitude of practical problems and interested mainly in their personal advantage. Mr. Taylor's work on *The Art of Cutting Metals*, which at times converted whole sections of shops into laboratories, is the conspicuous exception which proves the rule.

On the other hand, the successful administration of a new type of organization absolutely requires the determination of the principles on which it will be conducted. Starting, therefore, with the principle of basing all productive activity on law, Mr. Taylor was compelled to work out the principles which have now become known distinctively as those of scientific management. The science of industrial conservation is a free field open to every one capable of cultivating it, but the principles of industrial organization as developed by Mr.

Taylor are thus far the distinguishing possession of those trained, or strongly influenced, by him.

This analysis makes clear the fact that scientific management is the extension to industrial organization of the "positive" movements in current thought. The substitution of a basis of scientific law and principles for guesswork or tradition reminds one strongly of Auguste Comte's theory of progress from the "theological," through the "metaphysical," to the "positive" or scientific stage of thought.

It is interesting to observe that "scientific management" is "positive management" in other senses as well, which flow from its essentially scientific aim and method. Its administration is marked by the *positiveness of its control*. So far as possible nothing is left to accident or to individual judgment. The time, place, and sequence of all operations, as well as the details of all processes, are determined and enforced by the management.

The result of the application of the science of industrial conservation and the principles of industrial organization is to develop the inherent resources and capabilities of an organization far beyond the average or normal degree of efficiency. This distinguishes scientific

management from the current types of "efficiency systems," which are usually based on a variety of cost-keeping built on the methods of accountants rather than of statisticians and supplemented by superficial observations and incoördinated improvements. Their aim is to "stop leaks," "eliminate wastes," "avoid delays": in other words, to remove a mathematical negative and bring an organization to a normal standard. The aim of scientific or positive management is to carry an organization beyond this normal standard and to bring it to the utmost degree of efficiency of which it is capable: in other words, to accomplish a *mathematically positive* result.

II

FREDERICK WINSLOW TAYLOR

THE time is not yet ripe for the full story of Taylor's varied and active life. He was a notably two-sided man; on the one hand, a scientist devoted to the pursuit of abstract truth, and on the other, a highly practical man deeply involved in large industrial affairs. His work as a scientist, while in the main well known, led him into practical applications whose details have been to some extent withheld from publication for practical reasons; while his work as administrator and manager involved relations with clients which were necessarily confidential in their nature. His pioneer work on the advanced frontiers of the art of industrial management led him into situations of trial and difficulty which would make a story of exceeding interest were it possible to give it at this time.

Taylor has himself revealed some of the characteristic experiences through which he reached his development, but even with his most intimate friends it was his habit to maintain a high degree of reticence about certain of the

most interesting periods of his life. Perhaps in the fullness of time the many records available in Taylor's effects and the vivid recollections and reminiscences of his friends will be brought together and made into a volume, which will be at the same time a history of a highly important development in modern industrial life and a fitting memorial to the man to whose genius this development is largely due.

To give at this time a few of the significant facts which go to explain and illuminate his career and the movement of which he is the father, will not require the violation of confidences nor the divulging of secrets.[1]

Taylor was to a high degree the resultant of his ancestors. On his father's side he came of a long line of Pennsylvania Quakers. His grandfather was a merchant trading with the Indies; his father a lawyer. His mother's family was typically Yankee. Her father was one of the famous old New Bedford whalers, who not only attained to considerable wealth, but to the distinction of being commissioned by the French Government to assist in the development of the whaling industry by France.

[1] Much material of an autobiographic nature may be found in Taylor's books and need not be repeated here. The history of his literary work is given on pages 25, 179–94 following.

His mother was one of the leaders in the group of women of keen intelligence and independence of character who contributed largely to the transcendental tone of New England in the middle of the nineteenth century. She was an early advocate of women's rights. Her home was a center of the Abolitionist movement. Taylor came honestly by the moral rectitude and high regard for truth and the immovable firmness of conviction which characterized him, together with the apparently paradoxical, though really consistent (if you understand it), strain of pioneer radicalism.

Taylor was born in Germantown, Pennsylvania, on March 20, 1856. During much of his early youth he was at school in France and Germany, and before his return to America made an extended trip through most of the countries of Europe. During these years he developed a deep affection for France and the French people, and always numbered many of his best friends among them. In later years his favorite trip for recreation and health for himself and his wife was to the rugged but hospitable coast of Brittany. One of his last letters was an appreciation of the heroic efforts of France and Belgium to repel the German invasion in 1914 and the expression of an ardent

desire for the ultimate success of the French arms.[1]

On his return to the United States he was placed in the Phillips Exeter Academy to be prepared for admission to Harvard University; an ambition which he was destined never to realize, however, on account of the weakness of his eyesight.

One of his instructors at the Academy was the famous mathematical pedagogue whom he was fond of referring to as "Old Wentworth." It was from Wentworth that Taylor got his first idea of time study and the assignment of tasks. Wentworth would give an original problem in geometry to his class, take out his watch, and record results. As soon as a student had solved it he raised his hand and the time was noted. Eventually half of the class had solved the problem, and the elapsed time was an indication to Wentworth of the number of problems he could assign for a normal day's work.

When young Taylor left Exeter he was unable to continue his studies and undecided about the vocation for which he was fitted. Active and well-to-do, with leisure and no particular aim, he went in strongly for athletic

[1] See Le Chatelier's memorial volume, *Revue de Metallurgie*, vol. XII, April, 1915. (Dunod et Pinat, Paris.)

sports. During these years he developed a love for outdoor games, a skill in playing them, and a rugged physique which attended him throughout life. At one time he was one of the holders of the amateur double tennis championship and in his later years stood high in the ranks of amateur golfers. Many amusing details are told about the curious results of Taylor's application of his scientific methods to this game hoary with age. In order to insure an accurate grip on the driver and the proper swing, he had a harness constructed which made it impossible for him to drive otherwise than correctly. At the same time, in order to lengthen the drive, he had his clubs made extra long, so long in fact that they were ruled off some of the conservative old golf links. The head of his niblick was made of a coarse rasp file with the rasps pointing upward. While this was rather rough on the ball, it at least insured its getting out of a hole of any depth.[1]

As soon as he realized his bent toward engineering work, Taylor got a job as apprentice in the shops of the old William Sellers Company in Philadelphia. This did not work out to his

[1] One of Taylor's mathematical friends is reputed to have devised a slide rule for calculating the strokes and angles in billiards, but there is as yet no evidence of his having attained the championship thereby.

satisfaction, however, and in 1878 he applied for work at the Midvale Steel Company, near Philadelphia. There was nothing open for him except a clerkship, which he accepted unwillingly and shortly resigned to go to work in the shops as a laborer and helper. This connection was destined to become decisive in Taylor's career. In the course of a few years, from 1878 to 1884, he held successively the positions of clerk, helper, keeper of tool cribs, assistant foreman, foreman, master mechanic, director of research, and finally chief engineer of the entire plant. In 1880, when the trouble with his eyes had sufficiently subsided, he became a student in the evening classes of the Stevens Institute, where for three years he studied the fundamentals of engineering.

On this foundation Taylor developed a professional career as engineer and manager which eventually brought him to the position of one of the world's leading inventors, engineers, and administrators. The humble beginnings of his development are given in some detail in his own books. Until about 1889 Taylor was at Midvale. During this period he evolved some of the underlying principles of the type of management which has come to be known as the "Taylor System." Here the methods of time

study found their origin; functional foremanship began to take form; and the experiments on the cutting of metals, which later brought him fame and wealth, were begun.

From the expiration of his Midvale work to the beginning of his engagement with the Bethlehem Steel Company is a period over which the veil is still drawn. Taylor was then engaged in the development and application of his cost system and methods of management to a considerable variety of industries, chemical and mechanical. His work was carried on under the greatest difficulties. Radical and revolutionary in his methods, he was little understood by those with whom he was in constant contact. To add to his troubles, he was often in conflict with managers and directors remote from the scene of operations, unacquainted with the technology of the industry, ignorant of the operating conditions in their own plants or the problems of management which were always arising, and even in some instances insisting on methods of dealing with employees, suppliers, and the market, which were inequitable and oppressive and utterly contrary to Taylor's principles. Taylor was consumed with the ambition to carry on the experiments he had begun at Midvale. The expedients to which

he resorted to secure funds for this purpose were ingenious and successful as well as strictly ethical. One of the considerations on which funds and equipments were advanced to him was secrecy, and it is this which is largely responsible for the dearth of detailed information about his activities during these years. All that can be said is that when he emerged again at Bethlehem, he had arrived triumphantly at almost the conclusion of his work on the cutting of metals and at nearly the final development of the system of management which now goes by his name.

Taylor's services were engaged by the Bethlehem Steel Company in 1896. There for three years, with the assistance of a large and competent force of engineers, he reorganized the management and methods of two of the larger machine shops and the foundry, and at the same time completed the development of his metal-cutting experiments, made substantial advances in time-study methods, and did a masterly piece of work on the care and maintenance of leather belting. It was here that he finally worked out the formula and method of heat treatment for what is now known as high-speed steel. The old story that the heat treatment was discovered by accident through the

mistake of a workman is a sheer fabrication. High-speed steel is the result of four years of intensive study and experiment by Taylor, with the assistance of a metallurgist, Maunsel White. The work was done by laboratory methods of the most minute and painstaking character and the keenest scientific training and intelligence were constantly brought to bear upon it.

The circumstances under which Taylor closed his engagement with the Bethlehem Steel Company are not clear. After he had been there about three years a change in the directors and executive management took place and there came in a group who were unfamiliar with, and apparently antagonistic to, the methods pursued by Taylor and his staff. Whatever the details may be, the fact is that Taylor and his associates left. During the following two years his work was maintained to some extent, and then the building from which it was administered, and which contained the time study and other records which were its basis, was burned down. For some time thereafter the subordinate officials, who were familiar with Taylor's work and in sympathy with him, continued it as well as they could; but eventually it became encrusted with a mass of foreign

accretions until on the occasion of my visit there in 1912 it was barely recognizable. There was some evidence, however, even then, that Taylor's influence had not by any means been effaced. I was, in fact, told that a movement was under way for the definite reinstatement of at least some of his methods.

One of the plants to which Mr. Taylor went shortly after this was a roller bearing concern in Fitchburg, of which he gives some account in his books. It was there that the present typical methods of foremanship and the forms usually found in Taylor System plants reached their final development. The routing and cost systems particularly, as we find them to-day, were first seen in operation there.

In 1901 Taylor was engaged by James M. Dodge to systematize the Philadelphia shops of the Link Belt Company. Although still a comparatively young man, Taylor had decided to retire from the active practice of his profession, which he was enabled to do by the great financial success of his numerous inventions and of certain coal-mining operations in which he had been financially interested; so he turned this work over to one of his former associates, Mr. Barth, Taylor himself only supervising the development of the system.

About 1906 one of Taylor's friends, an engineer of high standing in his profession who had become president and manager of a small machine shop in Philadelphia, came to him in financial distress and asked for help. As usual, Taylor was most generous about giving assistance, but for two reasons made a condition that the plant should be thoroughly and completely reorganized in accordance with all the principles and methods of the Taylor System. One reason — the less important of the two — was his feeling that only in this way could he be sure of the ultimate rehabilitation and success of the company. The other and controlling reason was that this afforded Taylor an opportunity to establish an experiment station in management methods and a training school for young men who wished to learn these methods and extend their introduction in other plants.

For by this time scientific management (though it had not yet acquired this name) had passed through the stages of a profession and means of livelihood, an avocation and hobby, until it had almost become a religion with Taylor. In his recent years of comparative leisure he had had an opportunity to philosophize and generalize on his experiences, and the far-reaching significance of his principles and

methods had dawned upon him and waxed until it almost filled his mental horizon.

During these years since 1901 he had early written his now classic pamphlet on *Shop Management*, and in the years following he had devoted himself to the propaganda of the movement. He gave his time and his means freely to showing its operation in the Philadelphia plant to conscientious inquirers. In many instances he traveled far at his own expense to address associations and meetings of manufacturers and managers. Out of his own pocket he contributed to the expenses of young and ambitious engineers who were serving their apprenticeship in Philadelphia. At the same time he was writing his other masterpiece, *The Art of Cutting Metals*, which was presented as his Presidential Address when he was elected President of the American Association of Mechanical Engineers in 1906. During his incumbency of that office he reorganized its methods of administration. Later still, when scientific management had become popular, he contributed a simplified revision and restatement of his principles under the title *Principles of Scientific Management*.

It was during this period that the attention of labor leaders was directed to this new de-

velopment. Their reaction, unfamiliar as they were with the principles and methods of scientific management, was at first suspicious, then actively hostile. Taylor was untiring in his endeavors to make the subject clear to them and to show them its actual operation and results. In his last years he was often called upon to appear before congressional committees investigating the operation of the system in government plants.

It was in the performance of his missionary work that Taylor came to his death. He was invited to give an address before a number of associations in the Middle West. Although already worn out by appearances before similar associations and numerous committees, he accepted the invitation; and when stricken with pneumonia *en route*, his formerly robust physique was unable to rally to the emergency and he died, after a very short illness, on March 21, 1915.

The regard in which he was held by his coworkers, his scientific associates, and the public, was indicated by the impressive memorial services on the occasion of his funeral in Philadelphia, which was attended by men and women in all ranks of life and from all parts of the country, many of them there at considerable

personal sacrifice. A year later another memorial meeting was held in Philadelphia and similarly attended.

This brief account of Taylor's career will make more clear the curious combination of conservatism and radicalism which was found in him. He was of the distinctly "hard-headed" type. Nothing counted for him except facts, at least theoretically, for Taylor was only a little more immune than other human beings from the coloring which the emotions shed over the apprehension of facts. More than most others, however, Taylor was free from the intrusion of selfish interest. He had no regard for the effect the ascertainment of facts might have upon any personal considerations or upon accepted beliefs. It was this conservatism in regard to truth which led eventually to the radicalism of his deductions and the methods based upon them.

He had an Aristotelian confidence in the efficacy of facts as a convincing guide to human conduct. It was his belief that all action is related in a definite way to surrounding conditions and circumstances, among them the state of knowledge of the actor, and that motives may be formulated and reduced to law and utilized in the conduct of human affairs as

gravity is in mechanics. He was a determinist and a positivist.

While it is doubtless ultimately true that all human action is the resultant of definitely related forces, it is also true that these forces and their relations are so complex and elusive that they have, thus far at least, escaped our grasp. It is not to be wondered at, therefore, that Taylor's deterministic tendencies often encountered difficulties and obstacles in their practical application to personalities who at least thought they had a right to a choice and were capable of exercising it.

Taylor's ideal of educational discipline was that of the soldier, as exemplified at West Point. His liking for Germany was confined to a great admiration for her military efficiency. He was himself a stern disciplinarian; and when persuasion failed, and even self-interest when appealed to through the bonus method did not operate, he would apply, often with considerable effect, the "science of profanity," to which also he had given attention.

Neither should it be cause for surprise that, with his scientific, hard-headed temperament, he at times failed to comprehend the methods and motives of men of a different temperament. While on the whole he understood very

well the psychology of the workingman (so far as there is a psychology of "the workingman" as distinguished from the psychology of the individual), he did not grasp sympathetically the aspiration towards industrial democracy, nor could he see the point of the current contention that it does not follow necessarily, from the fact that a man *can* do a certain thing in a certain time, that therefore he *ought* to do it in that time. Theoretically Taylor appreciated the difficulty of developing a social instinct and intelligence in the masses of the people, but practically he had little patience with any one dense enough not to see what he saw. In the same way, he was unable to understand the habits, attitudes, and points of view of the scholar and the artist, although he was never at any time lacking in the keenest appreciation for genuine scholarship and artistic attainment.

He was too intelligent not to realize that there was some sort of gap between himself and certain of his fellows. To bridge it he had recourse to "diplomacy." His diplomatic methods and their effects were a source of almost as much amusement to himself as they were to his friends. With the most kindly interest and patience he would endeavor to convey some intricate idea, or to express his theoretical re-

gard for some movement such as labor unionism; and the next moment he would be damning most efficiently the density of his listener or the injustices and crudities of organized labor. Such diplomacy was as effective as might be expected.

In his scientific work Taylor displayed a characteristic combination of hard-headed regard for fact and a keen sense of industrial and social values. His scientific investigations, while marked by the methods and ideals of the student of pure science, were always directed toward the purely practical end of increased production for the social good and increased dividends for his employers.

In science, also, Taylor expanded the frontiers of engineering practice. His discovery of high-speed steel was epoch-making. It is safe to say that it has entirely revolutionized the whole machine-tool industry, necessitating as it did the construction of machines to bear much heavier strains than were before customary. His methods of administration also had an effect on the manufacture of machine tools through the fact that standardization of methods and instruction required a corresponding standardization of feed and speed ratios. While at Midvale, Taylor was confronted with

a need for a new steam hammer capable of handling sizes of work much larger than had been met in current practice. The usual way of securing the necessary stability for such a hammer was to increase its weight and solidity. It occurred to Taylor that stability could be secured in another way: namely, by taking advantage of the elasticity of the material used in the construction of the machine. At that time the laws of elasticity were practically unknown; nevertheless, Taylor worked through them and on their basis constructed a steam hammer of a greatly increased capacity and decreased weight, which was completely successful.

The breadth of his scientific interests and attainments is further indicated by the success of his experiments in the cultivation of golf greens, and it is said that his knowledge of horticulture and fish culture was exceptionally complete and accurate.

This is a temperament which, when in action, is referred to as a forceful personality. His leadership, whether exercised in the management of an indifferent or hostile force of executives and workingmen, or in the control of the friends who were associated with him in what has become known as the "Taylor group,"

was of the iron-handed type. He was always open to conviction; but when he had arrived at a conclusion based on what he justifiably considered adequate grounds, he had no patience with an attempt to reopen the question and grope again over the field which he had fully explored and mapped. At times he showed a tendency to an equal permanence of conviction on questions with which he was not so familiar, particularly those which are the battle-grounds of economists and sociologists. Discussions of such questions, however, usually ended in a modest confession of unfamiliarity with those fields.

For it must not be supposed that the softer side was lacking. Taylor was as modest about what he did not know as he was firm about those things which he knew he knew. He was much more modest than are most of his followers about the finality of his system. Where they have developed a ritual as well as a creed, he was content with the creed, and was happy to acknowledge any believer as a disciple so long as he practiced the Taylor principles, no matter in what form they might be expressed.

He was very free to credit all his associates and predecessors with suggestions out of which his developments grew and with the contri-

butions, often quite substantial, which they made to it. In his financial relations, while predestined to hard-headedness by his Yankee ancestry, he was exceptionally generous and charitable.

Without this softer side to his character he could not have had the world-wide circle of friends which he was happy to possess. His friends were held to him by the full faith he had in them, the encouraging support he accorded them in all their endeavors, the frankness with which he discussed their problems with them, and the sympathy and practical helpfulness of his advice and coöperation. Among the friends of whom he was proudest were many workingmen, laborers, operators at machines, straw-bosses, foremen, clerks, and others in the humbler ranks. The same qualities, even further refined and toned by affection, were shown in his home life.

Some day, when the time is ripe for the full story of Taylor's life, there will be revealed all the circumstances which moulded the man, and at that time, perhaps, it will be possible also to show fully the effect which the man had on circumstances. Misunderstandings now current, due to his reticence and conscientious silence and the difficulty experienced by a prac-

tical man in the effort to write clearly and to speak effectively on intricate subjects before none-too-well-informed audiences, to mannerisms of speech and gesture, and to the novelty of his ideas and methods, will gradually wear away. Their place will unquestionably be taken by the full and ungrudging recognition and appreciation of his fundamentally sound character and the great significance of his achievements. In fact, even now, the circle of his influence is spread around the world. By those who know him and his work best he is honored as a seer and a prophet, as a "master of those who know."

Taylor has left many followers, but no successor. As the influence of his directing spirit has widened, its force has diminished. Even during his lifetime the development of schools began. There is the original Taylor school which adheres to the letter to every form and mechanism which Taylor had approved. There is another school which allows a much wider latitude of methods and claims to devote greater attention to the human factor. There is still another school which allows so much latitude that it can only be called a Taylor development by reason of the fact that some of

its fundamental principles and methods were derived from Taylor and are still recognizable in spite of the changes they have undergone. In addition to these groups there are shoals of imitators under the name of "efficiency engineers," "efficiency experts," etc.

I do not believe it wise at this time to go further into detail on these subjects on account of conflicting claims to leadership, the interference of personal considerations and animosities (which had been effectively held in check during Taylor's lifetime), and the increasing commercialization of the movement. This will be proper for discussion by the next generation, when it can look back with cooler and more detached vision upon events and personalities which are now warm with life and too close to be seen in their right perspective.

III

SCIENTIFIC MANAGEMENT IN PRACTICE

At intervals during the past four years I have been investigating the actual working of scientific management in practice. The results here given are derived in the majority of cases from personal visits to the plants in twelve States and conferences with owners, managers, and experts employed. The information in regard to the others is derived mainly from the consulting engineers.

Information was sought with reference to the number, distribution, and types of plants to which scientific management has been applied; so much of the history and personality of the men engaged as is essential to an understanding of the development of their work; and the actual differences in practice between scientific and other types of management. Attention was also given to the results, both in the administration of plants and in the conditions of individual workers. The possible social consequences and tendencies involved in the movement offer a tempting field for speculation (which will be cultivated in another part of

this book[1]), and a few significant facts bearing on them were uncovered. In the feeling that a study of the failures might be almost as instructive as that of the successes, the facts in regard to them also were gathered and analyzed.

1. Statistics

The total number of applications of scientific management definitely known to me is 212. This does not exhaust the list, however, as there are some cases in which the client is unwilling that his connection with this movement shall be known, and others in which consultants are reluctant to give information. There is an uncertain number of such instances, probably small, in which either the work has been completed or is still in process.

Of these 212 applications, 4 are to municipal work, including three instances of consultation and one in which a scientific management expert was at the head of a Department of Public Works. Seven deal with railroad and steamship companies (exclusive of repair shops, which are classed as industrial) and 201 with industrial plants: 181 factories (including repair shops of four railroads), 8 public service

[1] See Chapter IV.

corporations, 3 building and construction companies, 3 department stores, 1 bank, 4 publishers, and 1 professional society. Of these 149 factories and repair shops are in the United States, and constitute practically 1.2 per cent of the 12,784 plants which in 1909 employed more than 100 wage-earners. The number of men in these plants, as nearly as I can estimate, is about 52,000, constituting about 1.3 per cent of the 4,115,843 employed in 1909 in plants employing over 100 wage-earners.

The 201 industrial plants included in the above classification are distributed as follows:—

Total United States			169
New England		53	
Connecticut	14		
Maine	4		
Massachusetts	28		
New Hampshire	3		
Rhode Island	4		
Middle Atlantic		58	
New Jersey	3		
New York	23		
Pennsylvania	32		
North Central		41	
Illinois	18		
Indiana	4		
Iowa	1		
Michigan	8		
Ohio	8		
Wisconsin	2		

Southern		10	
Delaware	1		
Maryland	5		
Mississippi	1		
Tennessee	1		
Texas	1		
W. Virginia	1		
Western		5	
California	3		
Oregon	1		
Washington	1		
Alaska		1	
Philippine Islands		1	
Foreign			32
Austria		1	
Canada		4	
England		4	
France		5	
Holland		2	
Japan		6	
Russia		9	
Sweden		1	

The most significant classification of manufactories, from the point of administration, is with reference to the complexity of their routing and order systems. On this basis the plants involved may be divided into two groups: first, the assembling industries, such as machine shops, repair shops, garment factories, of which there is in the United States a total of 96; and second, the relatively simple continuous and intermediate type, such as printing plants, foundries, textile plants, of which there is a

total of 51. Both these groups may again be subdivided with reference to whether they manufacture on order only, for stock only, or for both. Of the plants of the assembling type, 19 manufacture on order, 29 for stock, and 46 for both; while for the continuous and intermediate types, the figures are 26, 19, and 3 for the same subdivisions, leaving 5 for which information on this point is not available. The list of about 100 industries involved, classified according to product, is given in the footnote.[1] These figures, together with those for transportation companies, public service corporations, municipalities, and miscellaneous concerns should dispose of the question of the breadth of applicability of scientific management to various types of work.

[1] The following list will be found to differ from that published in the *Report* of the Sub-Committee on Administration of the American Society of Mechanical Engineers. The latter *Report* included some industries, such as sewing machines, brewing, and beet-sugar refining, in which there was merely consultation or a report which did not develop later into actual work; and others, such as tanks, tin cans, flour, leather goods, soaps, and slate products, concerning which I have been unable to get further information.

Agriculture	Bookbinding
Agricultural implements	Book cloths
Aluminum castings	Boxes (paper)
Ammunition	Box machinery
Automobiles	Brass beds
Axles	Brass castings
Banking (clerical work)	Brass products
Blank book making	Bricklaying
Bleaching	Building

2. Applications of Scientific Management

Before proceeding to a closer examination of the strictly industrial applications of scientific management, which of course constitute the great bulk of those that have been made,

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Buttons
Canning
Chains
Clocks
Clothing (men's, women's, children's)
Composing machines
Concrete construction
Conveyors
Cordage
Corsets
Department stores
Desks
Dies
Dyeing and finishing textiles
Earthwork
Electric apparatus
Elevators
Engines
Envelopes
Firearms
Food products
Foundry machines and supplies
Furniture
Gas
Glass
Gun carriages
Handkerchiefs
Hardware
Hoists
Import and Export trade
Iron castings
Iron and steel tools
Leather goods
Light, electric
Lithography
Locomotives
Lumber
Machine tools
Mining
Motors
Municipal engineering
Musical instruments
Optical goods
Ordnance
Paper
Paper pulp
Paper products
Power plants
Printing
Printing presses
Publishing
Pumps
Railroad cars
Railroad operation (steam and electric)
Railroad repairs
Registers
Rifles
Roller bearings
Rubber goods
Sashes and doors
Saws
Scales
Scientific and professional instruments
Separators
Ship building
Ship repairs
Shoes
Silk goods
Stationery
Steamship operation
Steel castings and forgings
Steel products, heavy
Structural iron
Textiles
Textile machinery
Torpedoes
Turbine engines
Typewriters
Valves and steam fittings
Watches
Wire goods
Wire weaving machinery

attention may be called to certain other activities in which some degree of success has been attained. Noteworthy among these is the work of Mr. Cooke, formerly Director of Public Works of Philadelphia, a disciple of the Taylor school. This work, made possible by the "reform", administration of Mayor Blankenburg, was marked during its three years of administration by large savings in the operation of that important department of the city's affairs. Owing to the peculiarities of the Philadelphia law, and the constant opposition of Councils and the previous almost inconceivably corrupt state of the department, it was not possible to make a thorough application of most of the fundamental principles of scientific management. The results attained, amounting to a saving of over $1,300,000, were due primarily to the injection of simple honesty into the department, and secondarily to the utilization, so far as conditions would permit, of expert knowledge secured wherever it was obtainable. Although necessarily a crude example of scientific management it accomplished enough to show great possibilities if a sufficiently long period and free hand were given for its completer development.[1]

[1] See the following: Annual Reports of the Director of

The Bureau of Efficiency and Economy of the City of Milwaukee has utilized the knowledge and inspiration of Mr. Emerson in the development of its plans; and the Emerson Company has also been consulted by the City of Seattle and the office of the Commissioner of Accounts of the city of New York.

Though the administration of department stores in general is so far behind that of modern factories as to constitute the former a particularly promising field for the application of scientific management, very little has been done in this branch of business. The actual selling of goods presents a problem so complex and with so many variables as to raise a question about the practicability of a complete application of all the present methods of scientific management. However this question may be answered, the administration of a department store includes many factors besides the selling of goods, — such as their purchase, receipt, storage, handling, packing and delivery, — which are essentially the same as the corresponding factory problems; and their costs are susceptible to similar treatment. In three department stores, to the writer's knowledge, a

Public Works, Philadelphia, 1912, 1913, and 1914. Business Methods in Municipal Works, Department of Public Works, Philadelphia, 1913.

beginning has been made on this side of the problem.

The practicability of applying some of the methods of scientific management — such particularly as the handling of raw materials, administration of tool room, and the establishment of standard times for operations — to the work of manual training schools has been demonstrated in a technical training school in New England, and in the department of engineering of the Pennsylvania State College. Suggestions for the wider application of these and other principles to the administration of colleges have been made by Mr. Cooke,[1] but so far as I know there has been no opportunity provided for a practical test of their usefulness.

Closely allied to the applications in manufactures and forming a convenient transition to them is the work done by Mr. Emerson on the operation of railroads, and by Mr. Day, one of the "Taylor group," on the operation of street railways and light and power plants. Owing to the complexity of the subject and the intricacy of the statistics available, there is dispute over the actual value of the work done on the Santa Fé and other railroads. Railroad statistics may

[1] *Academic and Industrial Efficiency*, Carnegie Foundation Bulletin no. 5, 1910.

apparently be used to prove or disprove anything, and there is evidence of a bias on the part of railroad men against allowing any value to Mr. Emerson's work. In the absence of an opportunity to make a personal investigation, I am forced to rely on what seems to be the consensus of opinion of judges as nearly unprejudiced as one is likely to find; and this consensus seems to be that on the whole the work was successful in reducing costs and improving administration, particularly in the repair shops and stores systems, while it was not so successful in its application to railroad operation.[1] On a road where special attention was given to increasing freight train loads, the statistical report shows a twenty-five per cent increase in the average load in one year after the work began. The value of this gain is questioned by railroad men on the ground that other factors supervened during this same period; but on the whole it seems that in this case also the greater share of the credit is due to the scientific management work.

What has been done in connection with the

[1] See besides Mr. Emerson's own accounts, those of Mr. Charles B. Going, *Methods of the Santa Fé;* F. H. Colvin, "How Bonus Works on the Santa Fé," *American Machinist*, vol. XXXVI, pp. 7, 165; C. H. Fry, *Railway Age Gazette*, vol. XLI, pp. 476, 504, vol. XLV, p. 413, and other references on pp. 220–29 following.

management of public service corporations is as yet not far enough advanced to warrant the formation of final judgment. So far as the efforts have gone, however, they have resulted in a definiteness of control which has made possible the stoppage of many leaks of frequent occurrence and have contributed to the determination of the costs and thereby of the reasonable rates to be charged for various types of service.

Returning now to the industrial applications with which this chapter will be mainly concerned, it is advisable first to point out the differences in practice between scientific management and other current systems. These differences are most notable in connection with the handling of labor, standardization of materials and equipment, the specialization of administration, and the application of the functional and "exception" principles to the organization as a whole. The primary object of the system is to increase output, reduce the cost per unit of product, and raise the wages of operators. This is accomplished: first, by determining with the aid of experienced investigators the best equipment, materials, and methods to use; second, by selecting and training the workmen best fitted to accomplish the result desired;

third, by determining in advance a standard of achievement for the workmen, providing them with the necessary working conditions, and rewarding them with a bonus for attaining this standard. This standard is set with reference to standardized conditions, by which is meant the determination and adoption of the best material and the best equipment obtainable, for exclusive use until a better is found and adopted. In accordance with the policy of specialization, the workman's activity is so far as possible confined strictly to actual handling of the machine or tool and of the material only so far as necessary to apply the tool to it. All other work is the function of the management. This is what is meant by the separation of planning from execution. In order to bring to bear most effectively the specialized planning functions, Mr. Taylor evolved, from the rate-setting department at Midvale in 1882 to the full complement of foremen at the Fitchburg roller-bearing plant about 1900, the method known as "functional foremanship," by which such details of administration as determination of the sequence of operations, machines, tools and methods to be used, time to be taken, relative importance of orders, recording of operations, instruction of workmen,

moving of materials, and maintenance of equipment and tools, are the special functions of separate foremen, each of whom is responsible for the proper handling of his detail with reference to a varying number of men, and all of whom bring to bear their specialized knowledge on each man. This peculiar type of organization is in every case supplemented for disciplinary purposes by the usual "line" type, in accordance with which there is the customary grading of disciplinary authority culminating in the superintendent or general manager, although some effort has been made to specialize this function in the hands of a "disciplinarian." In accordance with the theory that the ablest men are or should be the highest in the organization, the "exception" principle is used (at least in all the Taylor plants) by which all matters within the capacity of subordinate officials are finally determined by them and only such matters as are beyond their scope or authority are passed up the line, thus leaving the higher officials free to devote their time to the broadest and most important problems of administration.

These methods are characteristic of what may be called the original form of scientific management as early developed by Mr. Taylor

and his immediate disciples. Among those in the first Taylor group Mr. Gantt has made the most noticeable modifications. These consist mainly in simplification of forms and in somewhat less refinement of detail. The existing form of organization is left by him as nearly intact as the requirements of his central idea permit, while a simon-pure Taylorite aims at a complete reorganization. In practice also it is to be noted that Mr. Gantt sometimes installs a system with the aid of his own staff of men, whom he moves from plant to plant, while the other members of the Taylor group usually do their work personally and alone, getting their subordinates entirely from within the existing organization.

Mr. Emerson's theory differs from Mr. Taylor's mainly in the separation of what he calls the "staff" from the "line." Proceeding on the same principle, the necessity of accumulating the science involved in the industry, he organizes the experts in a staff of advisers whose duty it is to transmit their knowledge to the line officers, by whom it is passed to the operators and put into effect. In other words, this staff has no executive authority, while in the Taylor System the executives are themselves the experts. Practically the Emerson methods

differ much more widely than this from those of the Taylor group in that it is Mr. Emerson's policy to establish standards of performance and a bonus for their attainment as early as possible and by methods which are comparatively rough, as will be illustrated in detail later in connection with the subject of time study. Moreover, Mr. Emerson handles his work almost entirely through subordinates, among whom are some whose inadequate training has led to the majority of failures so far scored by scientific management. As Mr. Emerson has expressed it, it is his aim to take a plant that is forty per cent efficient and make it sixty-five per cent efficient; and, as he said again, the Taylor System begins where the Emerson System ends.

On account of the emphasis laid by certain members of the scientific management group on the technical and scientific aspects of their work, it may be worth while to distinguish between the technical and the pecuniary results. It would appear that in some cases the interest in perfecting a method by mathematical and experimental means would tend to overshadow the interest in reducing expense, increasing output, or improving quality. However, a study of the work of the successful

practitioners shows that their investigations have always been guided by financial considerations, and in fact in the most conspicuous cases, as in Mr. Taylor's experiments on metal-cutting, have paid for themselves by the savings attained. This coincidence of technological and pecuniary advantage was evident in every plant investigated.

A more important distinction, however, is that between what I have chosen to call "detailed" and "gross" results respectively. While trebling the output of a machine or a group of machines at a slight increase in direct labor cost may be considered a successful result in detail, it does not follow from such instances that the application of scientific management to the business as a whole has been successful. In the absence of information as to the total (gross) result, there may well be a suspicion of the final value of the isolated instances of wonderful improvements which have been so frequently cited. This total result, however, is particularly difficult to ascertain. I have found that while the owners of private plants have as a rule no hesitancy in pointing to individual savings and even net results of sub-systems such as stores, routing, and task and bonus, they are quite chary about the details of the total

cost of the system as a whole and the total savings and profits attributable to it. I was able to get this information in a meager way from a few private plants, but the best, most complete, and most reliable data on this side of the subject are found in reports of General Crozier, Chief of Ordnance, on the application of scientific management to the government arsenals. These total results will be discussed after the detailed accomplishments have been summarized.

As the central problem out of which Mr. Taylor developed his system was the control of the output of labor and machinery through the accurate determination of what that output should be, from the study of which all the other details of the system grew, it seems logical to discuss this feature first.

The determination of what constitutes "a day's work," or in other words the amount of output which it is possible for a capable workman to produce in a given time with given equipment and materials, rests in the Taylor System upon elementary time study. This was first practiced by Mr. Taylor at the Midvale Steel Company in 1882 and is still with some refinements and improvements the central and

most visibly characteristic feature of the system. Every plant investigated showed some evidence of time study, ranging from new rates based on recollections of former standards, as in the case of the Bethlehem and Midvale Companies, to the most elaborate and complete records and continuous extension, as found at the Watertown Arsenal and in the majority of plants now actively developing the system. In some industries these studies of elementary motions have been carried to such a degree of completion as to warrant the publication of the results.[1]

The most striking differences between the original Taylor form and the derived Gantt and Emerson forms of scientific management are to be found in the practical methods and applications of time study.[2] As practiced by the immediate Taylor group, a time study is

[1] Thus the elementary times in concrete construction are set forth in Taylor and Thompson's *Concrete Costs*, and similar data for the operation of machine tools, gathered over a period of thirty years, and for earthwork, are now in process of compilation for early publication.

[2] See the following articles: Taylor, *Shop Management*, pars. 323–408. H. K. Hathaway, *Elementary Time Study as a Part of the Taylor System of Scientific Management; Industrial Engineering*, vol. XI, pp. 85–96. Also in C. B. Thompson, *Scientific Management*, p. 520: C. E. Knoeppel, "Practical Introduction of Efficiency Principles," *Engineering Magazine*, October, 1914, p. 61, and further references on pp. 234–35 following.

made by first analyzing the operations of a workman on a given piece or on a given machine into their elementary motions; second, eliminating all elements shown to be unnecessary; third, determining by any one of several methods what is known as a reasonable minimum time for each of the remaining elements; fourth, summing up the elements to get a total minimum time; fifth, determining and adding to this a percentage of allowance made necessary by such factors as interference, fatigue, and inertia, and adopting this final time as the standard on the attainment of which the bonus is paid. Mr. Gantt follows the same method except that, as a rule, his studies are not so minute and the allowance is rather more liberal, thus making it easier for the workman to earn the bonus earlier and even to go under the bonus time. The Emerson method is radically different from either of these, in that the analysis of the complete operation goes down only to large groups of elementary motions, on which an over-all time similar to that which has been determined for years in all kinds of plants is ascertained. Emerson's times are expressed in minutes, whereas Taylor times are in hundredths of a minute. From these over-all times deductions are made according to the judg-

ment of the time study man, and the result is a standard which the workman is not only expected to attain easily but to exceed to a very considerable extent. This accounts for such expressions as 110 per cent or 140 per cent efficiency, which are possible and have a meaning only with reference to the Emerson type of time study.

Obviously the first cost and the difficulty of the Taylor method are greatest, those of the Emerson method least, and of the Gantt method intermediate. In general it may be said that the value of the results stands in the same proportions, though none of these methods is without its peculiar advantages and disadvantages. The less elaborate and expensive methods have made it possible, in some plants, to secure the advantages of the task and bonus idea early in the course of the installation of the system and at an expense which is practicable for small concerns to meet; while the more elaborate methods are comparatively slow and costly. The simpler methods have also been applied to some types of work where it is difficult or impossible to standardize and routinize elementary motions, such as drafting and die cutting. On the other hand, the most exhaustive type of time study insures a degree of accuracy

and finality which practically obviates the possibility of dispute, provides a stable basis of reward from which deviation is not reasonably to be expected so long as working conditions remain the same, and makes impossible a kind of fraud on the management which is fatal to the success of the system.

It is noticeable also that the Taylor form of time study requires and secures the services of experienced and technically trained chronometrists, whereas the simpler forms are deceptively easy and may be and have been entrusted to inexperienced and incompetent hands. This fact more than any other is responsible for a large proportion of the failures observed.

Motion study is an inherent and inseparable feature of time study and is constantly practiced by every expert chronometrist. In some instances it is found that a stop-watch is not used at all until a preliminary motion study has been made and the operation simplified in accordance with its suggestions. The latest development in this field — the use of moving pictures with a timing device in the field of the picture — has received much publicity, but does not appear to have been used to any considerable extent, partly on account of the

expense and partly because it has not demonstrated a practical superiority over the methods already current. There appears to be a possible field of usefulness for it in psychological and industrial laboratory work.

In practically every plant where the complexity of the work warrants, instruction cards of more or less elaborateness are used. In many machine shops it is the practice to issue to the workman an instruction card containing not only directions as to feeds, speeds, tools, and major times of operations, but also the elementary operations listed in their proper sequence and with their minimum time given. In other places I found the list of elementary operations is not provided for the workman, but he is given the total time and such subperiods as may be useful to assist him in earning his bonus. In still other instances, where the work is thoroughly standardized, as in book-binding and box-making, merely the total operation time is given, though in every case the total times and sub-times are made up in the planning department from the elementary data on file there.

So much has been published in regard to the practical results of time study and instruction card methods that it is unnecessary to go into

further detail here. As might be expected, the most substantial improvements have been made in machine shop work, where the highly technical nature of the factors involved has given special warrant for the assistance of expert investigators. Nothing is more common than instances of twofold and threefold increases in output from the same machine and the same workman. Larger increases—from seven to ten times—are not rare. On the other hand, a type of industry which would not appear to call for any considerable degree of technical knowledge, namely bricklaying, has shown equally astonishing results, an increase of from 200 to 300 per cent in the number of bricks laid per day having been demonstrated. With machines other than machine tools, however, it has not appeared practicable to secure such large increases in efficiency except in the direction of reducing the number of men tending one machine or of increasing the number of automatic machines tended by one man. It is not uncommon to find one man who formerly tended two gear-cutting or screw machines now taking care of five; I have also seen machines requiring formerly the attention of three men now taken care of by two. On the other hand, there are instances where the number of ma-

chines attended by one man was so great as to make it impossible for him to secure the maximum output on account of the interference of one with another. In these instances, of course, the number of machines per man was reduced. With the ordinary run of industrial machines, semi-automatic and each tended by one operator, increases of output appear to range from 30 to 100 per cent — the majority, so far as I have been able to find, nearer the lower limit.

The application of these methods to hand operations has shown very variable results. The extraordinary differences in efficiency between different workers on the same operation are already well known to managers. It is nothing unusual for even so-called skilled workers to do not more than one third or one half what others on the same work are able to accomplish; as, for example, in cigar-making. The time study and instruction methods of scientific management have increased the output of hand operators from 10 per cent to about 300 per cent, the majority of the cases lying between 60 and 100 per cent. Instances have been found, as in the case of gold-laying in a bookbindery, and in the sole-cutting departments of shoe factories, where economy in the use of material and quality of work were

more important than increase in output. These factors have been taken into consideration, the bonus arranged accordingly, and the desired improvement in economy and quality attained.

It must be understood, of course, that the results described do not flow alone from time study and instruction. I found that, in accordance with one of the fundamental tenets of scientific management, the task set for the operator was accomplished only with the utmost assistance of the management as represented in the stores and routing systems governing the standardization, availability and moving of materials, and the inspection system controlling the handling of defective work.

Where scientific management is fully developed the function of the purchasing department is essentially different from the current practice. Ordinarily the purchasing agent has the widest discretion as to what he shall order, when he shall order it, and in what quantities, subject in general of course to the requirements of the business, of which he is one of the chief judges. In the Taylor plants the requirements as to quality, quantity, and time of delivery for all materials are determined by production and technical experts in the plant, and the purchasing agent buys on orders and speci-

fications from the factory, exercising his judgment and discretion mainly on the matter of price. The governing considerations are the provision of materials for immediate issue when required for orders and the tying up of only such capital and space as are absolutely necessary to meet this requirement. In all instances of successful application, delay due to the absence of necessary materials has been practically eliminated. In many cases the variety of materials carried has been reduced even to one tenth of what was customary before. In almost all cases the quantities of certain materials have been reduced and of others increased, to meet the demands as shown by the record of issues. Occasionally, as in the case of several large machine shops, this has made on the whole a substantial reduction in the quantities and value of materials and of the space occupied by them. One manager said that he now carried one third as much material while doing fifty per cent more business. In some plants, however, investigation has shown that storage facilities and the quantities of materials carried were utterly inadequate, and this has led in such cases to a considerable increase in the storage space including even the addition of new buildings and an increase in capital in-

vested. This increase of capital was not proportional, however, to the increase of space, as the change meant in such cases greater concentration in storerooms of materials heretofore scattered over the operating area of the plant, and was accompanied by a standardization of material and reduction of the variety carried, which resulted in an increase in the quantity of the standard but a decrease in the total of all materials on hand.

Next to having on hand materials to work with, the most important factor in efficiency is the getting of these materials to the workman, together with the necessary tools and instructions, in the quantity and of the quality necessary, at or before the time he is ready to work on them. This is the function of what is known to scientific management as the "routing system" or (in the Emerson form) as the "scheduling" and "despatching" system. Obviously the complexity of this system will vary with the type of industry. At the one extreme of simplicity is the continuous, non-assembling industry, such as a sugar refinery; intermediate is such an industry as printing; at the other extreme of complexity are the non-continuous, assembling industries such as the manufacture of machine tools and automobiles. In general

it may be said that the need of effective and complete control increases with the complexity of the business. Scientific management has thus far been applied in the main to the more complex and the intermediate type, as will be seen by reference to the list on pages 40–41.

As might be expected, routing systems of varying degrees of elaborateness are found in practice. Many plants, such as certain typewriter factories, manufacture parts for stock, doing only their assembling on order. In such cases the routing of parts is easily standardized and administered; and the routing of the assembling is almost equally simple. On the other hand, several plants were found which manufacture from beginning to end almost exclusively on order, with specifications varying for each job. Repair shops are extreme illustrations of this. In such cases the routing system is necessarily elaborate and complex, and yet even in these is valuable, in the opinion of the managers, for the very reason that the variety and complexity of orders makes all the greater the danger of error, waste of materials, unnecessary motion, and delay at the machine. As the routing system usually involves the preparation of separate job tickets, inspection orders, and move orders for each

operation, its complexity is again influenced by the relative length of the separate operations. In one plant or part of a plant the piece or the lot may be at a given machine from four hours to ten days, as at the Watertown Arsenal. If this condition predominates, the number of orders to be written and handled is relatively small. Such is usually the case in machine shops. On the other hand, operations on individual orders and at each machine may be very short, ranging down from twenty minutes to two or three minutes, as in a stationery concern or a plant manufacturing small electric apparatus on orders. Where these predominate, the amount of clerical work and handling of orders is necessarily relatively great. This has in fact presented one of the most serious problems that scientific management has had to solve. There is usually a choice between an expensive completeness of control and a relatively inexpensive but risky incompleteness; and I do not believe it can be said that this problem has as yet had a thoroughly satisfactory solution. Where these conditions exist, the routing system of the original type is sometimes used in spite of its complexity, in the belief that it is indispensable to the successful administration of the task and bonus.

The intended result of the routing system is the complete control of the sequence and time of all operations, including moving from one operation to another. This result has been attained with varying degrees of success. In many plants the work in the factory is unquestionably controlled from the planning department, with only such assistance from shop foremen as is necessary to keep things moving and to carry out the orders of that department. In many cases, however, numerous exceptions to this control were evident, ranging all the way from leaving in the hands of the foremen control of the moving of materials or the assignment of work to specific operators, as at the Link Belt Company, to the entire administration of whole groups of work according to the old methods, as in the tool department of an automobile factory. In almost every case these conditions were said to be temporary, awaiting only the opportunity to extend the routing system to cover every detail of operation. In a few cases, however, it was stated to be a policy definitely pursued and to be continued, because either of the rapidity or the variety of operations or their infrequent recurrence.

Evidence of the effectiveness of the routing system is to be found everywhere where it has

been fully developed. Work goes through with a speed and certainty unknown to former types of administration. In printing plants, where practically every order is marked "rush," careful planning and coördination of work have almost wholly eliminated the hurry and confusion which usually accompanies a preponderance of "emergency" work. The manager of one large plant reports that this result alone has justified the installation of his routing system. Waiting for work by the operator has been practically eliminated and prompt delivery has become a rule in plants which practically never before were able to meet a promise date. One automobile manufacturer who had developed the stores and routing systems, but not the task and bonus, said that the routing system alone, a most elaborate one, had unquestionably saved him $535 per car. In other plants testimony varies (according to the type of industry) as to whether the routing system alone has been an economical institution; but where these plants have gone on to the development of task and bonus, they are unanimous in their assertion of its value as an indispensable accessory to that feature of management.

With reference to the inspection of materials, scientific management differs from other current

types mainly in its insistence on what it calls "first inspection," by which is meant the inspection of the first piece in a lot rather than waiting for the entire lot to be finished before it is inspected, the object being to detect misunderstandings and inaccuracies at the beginning of the operation and before more than one piece has been spoiled. With this has gone in most cases an increase in strictness of the final inspection also, considered necessary in order to counteract the possible tendency to neglect quality in favor of speed. In all cases the accomplishment of the task and earning of the bonus are contingent upon the satisfactory quality of the work.

An obvious result of the "first inspection" has been the reduction of waste; but more far-reaching and rather unexpected results have followed from the entire inspection system. The first of these has been the general improvement of operating methods which a rigid inspection has suggested and finally brought about, as in a box factory, where the close inspection of lined board led to an entire overhauling and revision of the methods of board lining; and the second has been the substantial improvement of the product which seems always to have marked the development of scientific manage-

ment methods. Thus, in one instance an American plant manufacturing roller bearings which heretofore had been unable to compete with European makers has so improved the quality as to secure a foothold for its product, even before the war, in spite of foreign competition.

One of the first results of the application of the methods of elementary time study was to make evident the importance and necessity of standardized conditions. Time study itself suggested means by which the working conditions of the operator could be made as perfect as practicable. A task set for one operator under these conditions and offered for acceptance to all workers logically required the establishment of similar conditions for the entire group. Out of this very quickly grew the policy of standardization of materials, equipment and plant — a policy which has been systematically pursued with rather spectacular results throughout the history of scientific management. First among these results must be mentioned the discovery of high-speed steel by Mr. Taylor and Mr. Maunsel White. This discovery was a by-product of the effort to standardize the tools with which the task was to be performed. Many illustrations of the same type of thing on a smaller scale might easily be given. Suf-

fice it to say that almost every plant now using scientific management in its original form has reduced its main material requirements to specifications, and that in many cases these specifications are for materials standardized and improved to meet particular requirements.

Concurrently with the standardization of materials has gone that of equipment. Mr. Taylor's work in the standardization of cutting tools and of belting is characteristic and famous, with that of Mr. Barth on machine design and also on belting running a close second. This work is of course still going on; and each new industry and even new plant is presenting opportunities brought out by time study for the continuous modification and improvement of equipment, the aim being always to increase the capacity and endurance of the machine and the ease with which it is handled by the operator. This extends also to small equipment such as trucks and hand tools. Usually, however, these efforts have been directed almost exclusively toward the immediately productive side of the plant, while the equipment for clerical work has been comparatively neglected — so much so that one is rather struck with the clumsy and inconvenient mechanisms often found in planning departments.

Because of the policy of scientific management to utilize existing plants to the utmost extent and postpone construction of new plant as long as possible, there has not been the opportunity for the application of scientific principles to design, construction, and lay-out which one would like to see. Nevertheless, one engineering company has made a specialty of designing plants in which scientific management is to be applied, and has produced a number of strikingly successful buildings from the point of view of convenient arrangement of departments and machines within departments, and the utilization of the best means for securing light, heat, ventilation, and sanitation. In the older plants, however, one is at times surprised to find how little attention has been paid to these details, with the exception of the arrangement of machinery, which is usually adequately taken care of. Lighting has had special attention in a few cases where the demand was imperative, and heating and ventilation in even fewer still. On the whole it cannot be said that these important matters have had the attention they deserve. An investigator cannot but be unfavorably impressed by the dinginess and stuffiness of some of the plants which in other respects are such

good examples of modern management. This condition is the natural result of the policy of owners who insist that all attention be given to those conditions which most directly and visibly affect the output. It should be said, though, that some of the owners of plants to which scientific management has been applied have realized fully the effect of exceptionally good working conditions upon the efficiency of their employees and have accordingly taken steps which bring them at least abreast of other concerns in welfare matters and which have the additional advantage of being based upon purely business rather than charitable or paternal considerations.

At the same time that scientific management was developing into its present form, the subject of cost statistics was engaging the attention of managers and experts. This detail of management in fact spread its influence far more rapidly than the more fundamental movement, partly on account of the fallacious feeling of useful knowledge that statistics are likely to give and the comparative ease with which they may be secured. To Mr. Taylor and his associates costs, though of course important, are secondary to productive efficiency. Mr. Taylor was one of the earliest of the profes-

sional cost experts, and the cost system that he evolved and that is now in use in a few plants is as simple as is consistent with effective ascertainment, recording, and distribution of expenditures. Without going into technical details, one of the distinctive features of the Taylor cost system is the use of the forms for the issue and movement of materials and for the control of operations as the original data for cost keeping. It is not the practice of scientific management experts, however, to insist on the use of this system, provided clients already have a sufficiently accurate system in operation. In a few instances, however (including a department store), I found that the cost system alone had been put in with results apparently satisfactory.

It has been pointed out many times that the principles characteristic of scientific management which have proved themselves capable of such successful application to production might and should be extended to cover the domains of selling and financing, with of course such modifications of method as the different problems presented by these subjects suggest. Thus far, however, the merest beginning has been made in this direction. One plant, a machine shop, has applied to its sales organi-

zation the principles of analysis of product, training and routing of men, and coöperation between the management and the salesmen, which it had long used in its production department. This is a small concern, however, and the methods thus far developed and the results attained, though satisfactory, cannot be said really to show the possibilities of a thorough application on a large scale.

At least one of the elements of scientific management, namely, a detailed analysis of the work of the operator with a view to setting standards of accomplishment to be made a basis of extra compensation in the form of a bonus, has been developed with some success in connection with the sales organizations of a number of concerns. The work of the salesmen has been analyzed in detail and certain "points" value attached to each element. The usual wages or commissions are paid and in addition the point system is used to insure the salesman's attention to those particular features which the management wishes especially attended to; and the accumulation of points from a basic standard is used as a guide to the payment of extra salaries.

The real test of the success of a system of management is not to be found in such isolated

examples as have been cited but rather in its net effect on the business as a whole. For obvious reasons it is difficult to get accurate information in regard to this from private plants. The most detailed exhibit of total costs and total results is to be found in the reports of the Chief of Ordnance on the application of the system to arsenals, particularly those at Watertown and Springfield, Massachusetts, and the Frankford, Pennsylvania. These results show in one year: —

Savings from improved shop management, and premium system...	$240,461.93
Savings resulting from the use of surplus stock....................	122,789.61
Total......................	$363,251.54 [1]

One private concern, manufacturing molding machines, reports that its product is now three times what it was before it adopted scientific management, while its total force has remained the same. Another is producing slightly more than it did six years ago with a little over two thirds the force it then had. A plant manufacturing automobiles (already referred to) reports that it is saving $535 per car; while a car-building concern, in which the application

[1] See *Reports of the Chief of Ordnance*, United States Army, for 1912, 1913, 1914, and 1915.

of the system had extended only over one year, reported already a saving of $100 per car. Another plant which had passed its dividends for several years found itself in a position, partly as the result of the development of the system, to declare a dividend of eighteen per cent. A structural iron concern reported that the total cost of installing the system, $18,000, was recovered by it in savings effected within three years. The results of the application of scientific management to the Santa Fé Railroad are hotly disputed; but on the whole it seems clear that considerable economies were accomplished.

The gross results, however, are not always so favorable. There have been partial successes and unquestioned failures, to say nothing of one curious example, a textile machine shop, which at the end of three years apparently showed a failure but in which a sudden access of energy brought about a complete and striking success. Failures, as will be shown in detail later, have been in some cases due to the financial inability of the concern to stand the cost of introduction over a sufficiently long period. In a few instances this condition was accentuated by panic conditions as in 1907; in a few others the cost was excessive by reason of in-

competent "experts" and the setting of tasks so crudely as to make possible excessively high bonuses. In general it may be said that wherever the development of the system has been allowed to be carried through to a conclusion, the outcome has been satisfactory; but that in some cases the cost of development and the slowness of returns have resulted in stopping the work long before it was completed.

3. Effects on Employees

Thus far we have been discussing the results of scientific management from the point of view of the employer. A movement, however, which has already affected over 72,000 employees (including about 20,000 in transportation in addition to the 52,000 in industrial plants), and which bids fair to extend to a much greater number, must be considered with equal care from the point of view of its influence and effect on the workman. Owing to the great number of units involved, an exhaustive survey of these effects will be out of the question for other than government agency. Miss Edith Wyatt investigated personally and rather fully the effect of scientific management on the woman employees in three plants.[1] The House Com-

[1] See Clark and Wyatt, *Making Both Ends Meet*, chap. VII.

mittee on Labor of the Sixty-second Congress made an investigation as the result of a brief strike at the Watertown Arsenal, and its findings are published in connection with their report.[1] General Crozier has gone fully into the question in his annual reports on the application of scientific management in the arsenals.[2] My information is derived chiefly from these sources, supplemented to some extent by such personal investigation as I have been able to make.

First as to wages. In no case that I could find were the basic rates lower than those customary in the industry and locality involved. In every case where the development of the system had progressed to anything like completion, the bonus principle was being effectively applied. Bonuses are figured in a variety of ways, which it is unnecessary to go into here.[3] By the Taylor and Gantt methods a considerable degree of efficiency has to be attained before any bonus at all is paid, but when the bonus point is reached the amount of premium is compara-

[1] *The Taylor and Other Systems of Shop Management.* Special Committee to investigate the Taylor and other systems of shop management. (Government Printing Office, Washington, 1912.)

[2] *Annual Reports of the Chief of Ordnance,* 1911, 1912, 1913, 1914. (Government Printing Office, Washington.)

[3] See references on pp. 250–51 following.

tively large, ranging from 25 to 100 per cent. By the Emerson method a bonus is paid for any increase above 67 per cent of the standard efficiency on a given job. This bonus reaches 20 per cent when the standard efficiency is attained and one per cent is added for each one per cent increase in efficiency. The Taylor method of time study and task setting makes it exceedingly difficult for workmen to exceed the task to any considerable extent; while by the Emerson method an exceptionally good workman is expected to go far beyond 100 per cent, and in practice has often done so. For this reason the range of bonus earned in the Emerson plants is from zero to 300 or 400 per cent; while in the Taylor and Gantt plants it has ranged from 20 to about 100 per cent.

The proportions of bonus earners to non-bonus earners also vary widely, depending partly on the degree of completion of the development of the system and partly on the policy of the management. It is the general expectation of the consulting engineers that the bonus will be applied sooner or later to about 90 per cent of the employees, the other 10 per cent being engaged in types of work which for one reason or another are not susceptible to the task and bonus method. This was found, with

one exception, to be the aim of the management. That exception was a foundry in which the manager explained that it was necessary to apply the bonus only to one out of three employees, as the increased efficiency which this incentive produced in him would compel the others to keep up with him. It must be said, however, that this is utterly contrary to the policy and method of the experts themselves and that, in general, no such method can be expected to succeed. In practice it was found that where the system had been in operation three years or more, there were from 50 to 85 per cent of the employees earning bonuses ranging from 10 to 60 or 70 per cent. In addition to this there was at least one plant using the Taylor differential piece rate in which the low rate is 10 per cent above that prevailing in the community, while the high rate is 43 per cent higher.[1]

One case was found in Chicago in which the bonus system was being abandoned because in the opinion of the management the men had not sufficient ambition to stir them to take advantage of it. An investigation showed, however,

[1] See Appendix I, *Report of the Chief of Ordnance*, United States Army, 1913, for tables giving experience at Watertown Arsenal.

not only that the men were on the whole rather shiftless but that the form of bonus offered by the management was not calculated to act as a powerful incentive. It can be said in general that the bonus method, when employed in the form recommended by the experts, has acted uniformly as a stimulus to increase efficiency, and that the claim that scientific management has invariably raised wages is easily substantiated by the facts.

It is pertinent to inquire, however, whether the increased wages due to increased output are obtained at the cost of the health of the employees. This question also was fully investigated by Miss Wyatt, with the conclusion that not only was their health unimpaired but that, on the contrary, the conditions under which the maximum efficiency is secured have led to improvement in health. The investigation at Watertown Arsenal was unable to find any case of injuries to health traceable to the system. Since that investigation it has been alleged that there has been an increase of accidents at the Watertown Arsenal. The analysis by General Crozier shows, however, that the increase of accidents has been among those who are not yet working on task and bonus; while for those who are operating under the

Taylor system there has been, on the contrary, a decrease of accidents.[1]

The attention given to the reduction of fatigue early in the development of scientific management is familiar to all who have read the accounts of the work of "Schmidt," the pig-iron handler at Bethlehem, and of the inspector girls at the roller-bearing factory in Fitchburg. The necessity of making an allowance for fatigue in establishing a task is too obvious to call for comment; and it is now as always an essential part of the work of an experienced chronometrist to take this factor into

[1] This point is so important that it is worth while to give General Crozier's statement regarding it. "Careful record of all accidents is kept at the arsenal. Most of the accidents occur in the machine shop. During the fiscal year ending June 30, 1913, the total number injured in this shop was 34, of which 5, or 14.7 per cent, were working on premium at the time. During the fiscal year ending June 30, 1913, 57 persons were injured in the machine shop, of which 13, or 22.8 per cent, were premium workers. During these two years the number of workmen employed in the machine shop remained about the same, but the amount of premium work increased nearly fourfold. That is, while the amount of premium work increased about 300 per cent, the percentage of accidents to premium workers increased only 8.1. During the nine months from October to June, 1913, 33 machinists were injured, 10 of whom, or approximately 30 per cent, were premium workers. During this same period 44.8 per cent of the work in the machine shop was premium work. It thus appears that the percentage of accidents among the premium workers was less than the percentage of premium work; that is, that the greater proportion of accidents during these nine months occurred among the day workers." (*Report of the Chief of Ordnance*, 1913, Appendix I, p. 68.)

account, not merely with reference to the motions of the operator but with reference to the redesign of machines and equipment to the end of reducing the necessary motions to a minimum. The result of this process is well illustrated in the case of a machinist I saw in Philadelphia. This man is now operating five automatic gear-cutters instead of the two which used to be considered his limit. In the handling of the gear blanks the worker showed a precision and ease of movement resulting in the maximum of accomplishment with the minimum of effort, which is in the strongest contrast to the nervous haste which in most plants is accounted speed. Incidentally it may be noted that this man is now earning $11 a day.

One difficulty has been found in a few instances of over-eagerness of employees to undertake larger tasks than those proposed, with the idea of earning larger bonuses. In two plants, employing girls mainly, in which this condition arose, operators were allowed to try the larger tasks under the supervision of the factory nurses. In one instance the new task was obviously too great for the operator; in the other, although the operator seemed to be able to accomplish it, it was felt that the arrangement might not be permanently satisfactory; so

in both cases they were put back on the tasks as originally set.

The extent to which the interest, loyalty, sobriety, thrift, and ambition of employees are increased, as is claimed by the advocates of scientific management to be the natural and usual result of their work, is difficult to determine in detail. If one may judge from rapid personal inspection of employees at work under the system, there can be no question of their closer application and deeper interest in the work they are doing. This interest extends beyond their own work to that of the management. Inasmuch as the success of the worker in earning the bonus depends partly on the smoothness with which the administrative department is conducted, the foremen and other executives receive numerous and forceful suggestions on this score if anything goes wrong. I have often seen workmen reminding their "bosses," in no uncertain terms, of their failure to live up to their managerial responsibilities. In fact, the authority of the operators within their own sphere is one of the outstanding peculiarities of a scientific management plant.

Perhaps the most striking evidence of loyalty of employees under scientific management is the

length of time they remain with their plants and the relatively infrequent changes in the pay-roll. This has further been illustrated in the demonstrated difficulty or impossibility of inducing even union employees in these plants to walk out or stay out in sympathetic strikes, as was the case in Philadelphia in 1910. With reference to sobriety, experience has shown that immoderate drinkers are incapable of standing up to the work, with the result that they have gradually eliminated themselves from these plants. Thrift and ambition are qualities which cannot be created by scientific management; but the opportunity for their exercise may be provided by a favorable environment, this environment including high wages and the recognition of superior ability. Such an environment is provided by the system, and my observations confirm those of Miss Wyatt to the effect that the favorable conditions are being taken advantage of. On the other hand, there have been a few instances where a tendency to extravagance and dissipation has also been increased by the bonus.

An investigator is forcibly struck by the notable increase in the personal efficiency of operatives who have worked for any length of time on task and bonus. This is the logical

result of the intensified personal instruction given them by the management. Another consequence of this instruction has been the development of employees to the promotion point faster than it was possible to find openings for them. The condition has occasionally been met by finding them better paid and higher positions in other plants. Another characteristic result has been the broadening of the technical proficiency of the employee which follows from the method sometimes pursued of training them in several varieties of work, in order to interchange them from one department of a factory to another to meet seasonal fluctuations of the demands in various departments. The possibilities of this policy have not, however, by any means been exhausted.

While the results just described apply to the great majority of workers affected by this system, there is no doubt that there have been instances of less satisfactory consequences. It seems generally true that in the first application of time study methods, the operators studied are made considerably discontented and "nervous" by the process. While as a rule this nervousness and discontent soon disappear, there appear to be some men who never get used to time study. A competent practitioner

recognizing this fact transfers his time study to some other operator, in which case the individual too nervous to be made the subject of a time study usually has no objection later to accomplishing the resulting task. There has also been at the beginning of development in various plants considerable dissatisfaction with the share of the increased profit paid to the workmen as a bonus. They have not been able at first to see why, if production is increased 100 per cent, their wages should be increased but 30 per cent. A clear explanation, however, of the part taken by the management and the expense undergone by it in providing the conditions under which the increased production is alone possible, has in the great majority of cases been satisfactory to the employee.

While the task is set for the average good worker, it has purposely been made sufficiently difficult to act selectively, and there have been employees unable to accomplish it at first who in their discouragement have left their jobs before they had reached the bonus-earning point. In addition to these there are undoubtedly some who were incapable ever of attaining the standards set. Bonus records as kept in various plants, however, show that the proportion of these employees is very small. On

the other hand, I have been unable to find any evidence of overstrain in the effort to earn the bonus.

The question has been raised whether the rigid standardization of processes and the precise instructions to workmen have not tended to suppress initiative, judgment, and progress. Strange to say, the only evidence I have found of this has been on the part of the consulting engineers themselves, with some of whom the comparative perfection of methods developed ten years ago has tended to preclude the admission of the possibility of advance through any apparently radical or substantial change. With the workmen, however, it is generally true that the greater skill resulting from standardization and instruction has led to a correspondingly greater confidence and freedom of initiative and suggestion, and many of the detailed improvements worked out in practice are credited by the experts to the workmen themselves.[1]

[1] See C. B. Thompson, "The Case for Scientific Management," *Sociological Review*, vol. VII, p. 315.

4. Relations with the Public and with Organized Labor

When we turn from the employer and the employee to the third party in interest — the public — we find the available data to be quite limited, due mainly of course to the comparatively short time that scientific management has been a real factor in industry and the relatively small proportion of plants using it. There is sufficient information available, however, to point to far-reaching ultimate social effects and consequences. At this point such facts as we have will be briefly stated and the discussion of economic tendencies with probable results continued in a later section.

That scientific management has had the effect of raising losing concerns into the profit-making class and thereby retaining a certain degree of competition which might otherwise have been reduced has been evident in several cases, some of which have already been pointed out in our discussion of gross results.

There is no strong evidence at the present time to show that the increased efficiency of scientific management has resulted in lower prices to the public, for the reason that most of those now using it stand in a quasi-monopoly

position in which there is no necessity for them to reduce their prices substantially below those of their competitors, notwithstanding their larger profits. An interesting question is being raised by the fact that public service corporations operated under scientific management are in a fair way to show unusually large profits based on rates which would be considered normal for concerns operating by the usual methods. Will public service commissions apply to these more modern concerns the eight per cent rule, thus depriving them of the benefits of their superior management? The one instance in which the public has benefited conspicuously by the reduction of price is in a very highly competitive industry — the automobile industry — in which the reduction in the selling price of the car was apparently the essential condition on which the concern could live. In this instance a car selling with small profit at $2950 has been reduced in price to $1950 with a considerable increase in profit. The result is said by the company without qualification to be due to the application of scientific management.

The one phase of the relations of scientific management to the public on which considerable information is available is that of its

relations with the labor problem and more particularly with organized labor. The social import of the general increase of wages through the bonus for the individual employee varies of course with the number of employees involved. Thus far it is safe to say that it has affected about 70,000. These are widely scattered, however, and no notable social advantage has accrued.

The selective methods of scientific management would appear to have some bearing on the problem of unemployment. Thus far it has been the consistent policy of consulting experts never to discharge an employee on account of changes in the system of administration. It is also their policy to spur the management to such an increase in its selling activity as to take up the expected increase in production as rapidly as the latter is attained, hoping thereby to retain or even add to the number of persons employed. In many cases the management has succeeded in increasing its sales in the manner and with the result suggested. In other instances, however, the result has been ultimately a decrease in the number employed, brought about, not by the discharge of employees, but by refraining from filling the places of those who in the natural course

of things drop out. The dropping-out process has also been facilitated somewhat by the application of the task and bonus, as a result of which those who are for any reason dissatisfied with it seek employment elsewhere.

The net effect of these changes, however, involving as they do but a small part of the total number of employees, widely scattered, and resulting from a process necessarily slow in its development and carried on by a small number of practitioners, is exceedingly slight; and it cannot be said that scientific management has as yet, no matter what its future influence may be, seriously affected the problem of unemployment.

The American Federation of Labor, however, has devoted a considerable share of its attention to what it considers the dangers of scientific management. The agitation against it seems to have originated in the International Association of Machinists. In 1911, Mr. James O'Connell, at that time president of the Association and later a member of the famous National Industrial Relations Commission, issued a fiery circular to his constituents condemning wholesale his conception of the Taylor System. The strike of the molders at the Watertown Arsenal in 1911 drew the attention of

other labor leaders to the system, and Mr. Frey of the International Association of Molders and Mr. Duncan, first vice-president of the American Federation of Labor, Mr. John Mitchell, and many other officials, have since taken up the cudgels vigorously. Their opposition is aimed primarily at the possible weakening of the cohesion of organized labor under scientific management based on known facts; and particularly against the insistence on individual bargaining, which has marked the practice of Mr. Taylor and his associates.

At the Seattle Convention of the Federation in 1913[1] and the Philadelphia Convention in 1914,[2] resolutions condemning the system were adopted. At the same time a determined and successful effort has been made to introduce and pass through Congress a bill to prohibit the use of the stop-watch or any premium or bonus system in any plant operated by the Government, aimed of course at the Taylor System as developed in the arsenals.

The resolutions and speeches of labor leaders and their congressional advocates have thus far been marked by a conspicuous lack of in-

[1] See *Report of Proceedings*, Thirty-third Annual Convention of the American Federation of Labor, held at Seattle, Washington, November 10 to 22, inclusive, 1913, page 299.

[2] See *Report of Proceedings*, p. 326.

formation in regard to the system they are condemning; and scientific management exponents and managers of plants using the system have observed a great reluctance on the part of these leaders to avail themselves of the opportunities frequently offered them to secure at first hand the information for intelligent dealing with the subject. The exhaustive investigation of the House Committee on Labor of the Sixty-second Congress resulted in a report recommending that no legislation [1] be made, as the deleterious effects alleged by the opponents of the system had not been found in practice. The House Committee on Labor of the Sixty-third Congress, without an investigation, reported a bill proposed by the labor unions, which was passed by both houses in the form of a rider to the Fortifications Bill, prohibiting the use of a stop-watch or the payment of bonuses in the government works.[2] On account of an error of the labor leaders in attaching this rider to the wrong bill, the payment of bonuses was continued. In the Sixty-fourth Congress various similar bills were introduced,

[1] *Report*, Special Committee to investigate the Taylor and other systems of shop management (62d Congress, 2d Session, House Report 403, 1912).

[2] See the very interesting debate on this subject in the Senate, reported in the *Congressional Record* for February 23, 1915.

and eventually the provisions of a bill fathered by Representative Tavenner, of Illinois, were embodied in amendments added to several of the great appropriation bills. These amendments were passed at the instance of the unions and despite the most serious opposition of representative employers and many employees.[1]

Mr. Taylor and most of the other practitioners of scientific management, while recognizing the historical benefit of labor organizations, have insisted, thus far, that there is no need for them in plants enjoying the favorable conditions for labor created by their system; and further that in such plants there is no place for collective agreements, inasmuch as in their opinion all the matters which might be made the subject of collective bargaining are matters of fact determinable by experiment and not subject to agreement or opinion. They insist further that in their experience there has been no necessity for considering particularly relations with labor unions and that such consideration would only add to the already large difficulties of their work.

[1] See *Hearings before the Committee on Labor, House Report*, 63d Congress, on H.R. 8662, April 17, 18, and 20, 1914. See "Method of Directing the Work of Government Employees," *Hearings before the Committee on Labor*, 64th Congress, on H.R. 8665. Also *Report*, 64th Congress, H.R. 698. (Washington Government Printing Office, 1916.)

In spite of the fact that many of the plants now using scientific management have among their employees members of unions, and notwithstanding the public opposition of labor leaders, the only instance of actual organized opposition to the original Taylor System was that at Watertown already referred to, where the molders walked out during the absence of the consulting manager and on account of a detail of the work begun without his authorization. This difficulty was soon adjusted, the men went back to work and have been working continuously since, although in the mean time the matter has been taken up by their official leaders and made the subject of petitions to the Secretary of War [1] and the agitation in Congress already described.

There have been a few instances of "labor troubles" in connection with the installation of certain derived forms of the Taylor System, due in general either to the bungling of a subordinate on the job, as in the case of a certain plush mill, or to the irreconcilable attitude of the union leaders, as in the case of the engineers on the Santa Fé. In other plants there have been conferences in a few instances between

[1] See Appendix to *Report of Chief of Ordnance*, 1913. (Government Printing Office, Washington.)

the management and representatives of local unions concerning details of administration, and arrangements satisfactory to both sides have been effected. In a few cases the extension of scientific management from unorganized parts of the plant to other departments highly organized has been delayed on account of the fear of labor union opposition. In several instances efforts of organizers to unionize departments using the system have failed on account of the satisfaction of the employees with the conditions of their work. In one plant where scientific management was fully developed and in complete operation, the management, for reasons unconnected with the system or with working conditions, has itself authorized and aided the organization of its employees. In the great majority of applications, however, there is no attention paid to the question whether the employees are unionized or not; and local unions conversely have ignored the development of the system.

That the general satisfaction of the employees under scientific management has had a stabilizing influence in the direction of industrial peace has been illustrated in a number of instances like that already cited of the general strike in Philadelphia in 1910. In other plants,

during the I.W.W. agitation in 1911–12, the employees kept themselves well outside the drift toward that organization. It is evident on the whole that the realization by the employees of the fact that scientific management automatically provides, at no cost to them, higher wages and better working conditions than can be shown by labor organization, has weakened the hold of the latter upon them. When to this is added the instinctive defense of the principles of collective bargaining, restriction of output, and uniform wages, by the labor leaders and the reaction to a fighting attitude on the part of some leaders in scientific management, we have the chief factors to which must ultimately be laid the persistent opposition of the labor officials.

5. Failures and their Causes

It is well known that the efforts to apply scientific management have not met with uniform success. The results have ranged all the way from absolute failure, by which is meant the complete cessation of work on the system at any point in its development and the rejection of what had been already accomplished, to complete success, by which is meant the development and retention of all details of the

system in their application to at least one complete department of a plant. Between these two extremes are many cases of partial success, by which is meant the development and retention of some important detail such as the stores, routing, or cost sub-systems.

Of the 113 industrial plants for which information on this point is available, and in which the work has progressed far enough to warrant the formation of a judgment, 59 may be called complete successes, 10 partial successes, and 34 failures. Twenty-seven of these 34 failures are connected with forms of management derived from and more or less related to the Taylor System, which amounts to 42.2 per cent of the applications of such forms. Seven are connected with the original Taylor forms, which represent 14.6 per cent of the application of these original types. Of the 28 cases now to my knowledge in process, there is good reason to suppose that 22 will be partial or complete successes, and that 5 will probably result in failures.

An analysis of the causes of failure shows a noticeable concentration about two factors — the personality of the consulting engineers and the personality of the management. Several failures are due to the inexperience and incom-

petence of the so-called "experts" put on the job; others to their lack of adaptability to new conditions or to the personality of the owners; and still others to an unwillingness on the part of the expert to familiarize himself personally with the shop operations. In at least two cases the experts spoiled their chances of success by indulgence in impractical and expensive experiments. In one instance the wholesale importation of outside men (made necessary, it is true, by the unwillingness of the management to provide men from its own staff) was a large contributing factor.

On the other hand, even more cases of failure are due to the management itself. Chief among these has been the spasmodic way in which owners, without due investigation or realization of what the development of scientific management meant, have rushed into it only to begin to vacillate before the engineers had had time to produce any substantial results. This has been the case particularly where the owners have gone into scientific management in response to advertising or other forms of solicitation. In a considerable proportion of the failures there has been marked dissension in the management, notably in certain instances where the foremen have for a long time en-

joyed practical control of the business. This condition is fostered also by absentee control, or control by financiers or lawyers unacquainted with the practice of industrial management and therefore unable to adjust the inevitable difficulties which arise between subordinate officials and experts in almost every case. There must be mentioned also a few cases where the sheer incompetency of the management made success under any system impossible.

In a fairly large proportion of instances failure was due to the financial inability of the owners to carry through the development they had begun. Occasionally this has been due to lack of foresight, but in the majority of cases to the supervening of a period of severe business depression such as occurred in 1907 and in 1913–14. In one or two instances this has been complicated by the cessation of sales for the product manufactured, due either to a change of public taste, as in the case of a factory making bicycle roller bearings, or the failure of the selling organization, as happened in a garment factory. In but one instance to my knowledge has the threat of labor difficulties been even partially responsible for failure, and here the situation was so complicated with financial troubles (in 1907) and an unsympathetic man-

agement that it is difficult now to determine precisely what weight should be given to this factor.

As may be expected, these causes of failure have in practically every case operated in combinations of two or three or more. The striking fact deducible from the investigation is that, with one possible exception, the failures have been due entirely to the experts or the managers and owners or both, and never to difficulty with workmen — and this independently of whether the workers were organized or not.

6. General Influence of the Movement

A discussion of scientific management would not be complete without some reference to the influence of the movement outside of its recognized application. It is safe to say that scientific management shares with the modern movement of cost statistics the credit for the widespread interest in the improvement of methods and details in factories of every type. Cost systems are easier to develop and apply than production systems. They have, therefore, had many more exponents and are far more generally found. Their showings, however, have had the direct result of pointing out the necessity for production systems to eliminate waste made

evident by cost statistics; and the two movements have, therefore, gone hand in hand, although "production engineering" only now is belatedly coming into its own. A brief perusal of the many factory and technological magazines and journals, and of the proceedings of the numerous meetings of manufacturers' associations, gives the clearest evidence of the large share of attention factory managers and owners are now giving to modern production systems.

It is also to be noted that since the attention of railroads was so forcibly called at the famous Eastern Rate Case hearings in 1911 to the work on the Santa Fé, they have been considering with a great deal of seriousness, though with little or reluctant acknowledgment, the kind of detailed analysis, supervision, and development from a new point of view which was then shown to be possible and profitable. This tendency has doubtless gained in momentum as the railroads recovered from the strain of public criticism brought out at that time. It is aided also by the development of more refined and minute cost methods which are only just beginning to make themselves felt. That the systems ultimately developed by the railroads will be similar in appearance to those now found

in factories operated under scientific management it would be rash to assert. But it is safe to say that the application of similar principles to their particular problems is being made to some extent and will be carried to far greater lengths in the reasonably near future.

Certain of the fundamental principles of scientific management, such as the economy of motion, energy, and time, and the detailed control and coördination of the work of organization, have made an effective and practical appeal to the professions. This is evidenced by the movements for greater efficiency in education, legal administration, and even in the conduct of social service, churches, and religious organizations.

And, finally, must be noted the radical change which the widespread publicity given the scientific management movement has brought over the popular conception of efficiency. Heretofore the policy of doing one's everyday work in the most perfect way has been considered a matter of æsthetic satisfaction, an artistic pleasure, and therefore to be pursued only in accordance with the dictates of one's "temperament." Now, however, the conservation of personal effort is interpreted as an important phase of the broader movement for the

conservation of all resources. It is considered economically advantageous, and, therefore, a personal and social duty. The general acceptance of this attitude will prove, in the long run, I think, the greatest social benefit that will have flowed from the work of Mr. Taylor and his associates.

IV

ECONOMIC ASPECTS OF SCIENTIFIC MANAGEMENT

It may fairly be said after several investigations that scientific management has succeeded in bringing about a lower cost of production, higher wages, and better quality of product in the industries to which it has been applied. It has also already shown its effect in the selection of a different type of managers and of workmen from that usually found in industry, a higher degree of specialization, and a more individual and effective training. These are the broad facts on which the following discussion is based.

The questions in which we are now interested concern themselves with the effect of scientific management on business initiative and enterprise and the manager or *entrepreneur* who undertakes the risks.

Notwithstanding that it is an open question whether the effect of scientific management upon enterprise and industrial leadership is not of more consequence than its effect upon wages and the labor problem, the present tendency

is to lay all the emphasis on its relations to labor, in accordance with the general theory that numbers are the most important element in a democracy. Nevertheless, something may be said for the belief that the cultivation of a trained leadership is more advantageous both immediately and in the long run to the masses of "the people" than may be the surrender of such training and leadership in the interests of a hazy, ill-defined, and undirected "democracy."

The interest of society in the encouragement of enterprise and the development of competent *entrepreneurs* must not be lost from sight. By this it is not meant to minimize the right of "labor" to its just share of consideration, or even to a share more than mere justice would accord, in partial compensation for its historic wrongs and its relative weakness. Scientific management has in fact interested itself in the welfare of the workingman as its prime consideration practically from the beginning and such is the first interest of its leading practitioners to-day.

This phase of the matter will receive much attention elsewhere,[1] however, and at this point I propose to discuss the probable effects of positive management on management and the owner-manager or *entrepreneur* as such.

[1] See pp. 116–56 following.

I. Scientific Management and the Entrepreneur

The effect of the characteristic "exception principle," by which only those questions come up to the manager and owner of an enterprise which cannot be solved by those under him, is a tendency to inject successfully into the conduct of business a class of trained and professional administrators in addition to the current type of intuitive "captain of industry." In the more usual types of organization the head accepts the responsibility, not only for the general guidance of his business, but also for the handling of a great mass of detail, more, in fact, than it is humanly possible to take care of adequately. The result is that only the exceptional business man survives at all and only the type verging on genius achieves success on a conspicuous scale — and that largely through the intuitive use of the exception principle. This principle makes it possible for the average man, more especially if he has been trained in modern methods of analysis of problems and expeditious handling of his personal affairs, to dispose of such questions as come before him with a far greater probability of satisfactory results.

I do not mean to convey the impression that there no longer remains a place for enterprise, initiative, and shrewdness. There is no satisfactory substitute for these unfortunately rare qualifications. The genius in business, like the genius in invention, is still essential to the progress of civilization. It is a matter for very serious consideration, however, just how far these qualities do enter into the successful conduct of ordinary business. That they are necessary to the conspicuous and successful development of large-scale enterprises is undoubtedly true; but it seems probable that their importance in the everyday humdrum management of medium and small-sized concerns has been somewhat exaggerated. Many such concerns are now operating with apparent success, notwithstanding that their managers show no evidence of exceptional shrewdness, enterprise, or initiative. It may almost be said that these qualities have already been supplanted in the majority of instances by the capacity for attention to detail, careful analysis of not too difficult problems, and a consistent willingness to work — which is *not* genius, notwithstanding the well-known definition. Scientific management tends to develop more of such ordinary capacities, thus to increase the number of *entrepreneurs*.

The new type of management has brought about an increasing regard for technically trained men. So true is this that engineers are exhibiting a tendency to consider themselves the only qualified managers. That they are becoming more important in management is a logical result of the increasing reliance of business on science; but scientific training of every kind, not only in mechanics and chemistry, but also in psychology, economics, and business itself, has its importance correspondingly enhanced. It may be added that all this is at the expense of the favoritism and nepotism which still prevails to so large an extent. Grandsons, nephews, and old college chums may continue to draw dividends, and perhaps salaries even, but they are in danger of being retired from active participation in management.

What may be the effect of scientific management on competition and large-scale production? One reason for the typical modern development of industries on a large scale has been the opportunity that is presented only to large-scale industry to take advantage of the increased fruitfulness of the more minute division of labor. Scientific management subdivides labor still further, and thereby increases the advantage which the industry large enough to utilize such

subdivision may derive from it. It thus pushes farther ahead the stage at which the disadvantages that develop in large-scale organization overwhelm its advantages. If the large-scale organization succeeds in the application of scientific management before its smaller competitors take advantage of it, the result would be to accentuate the advantages the larger organization already has and thus to render effective competition more difficult.

The fact is, however, that the large-scale organization shows an inclination to rely on its size alone to keep the market to itself. Its smaller competitor is driven to greater efficiency of production as well as of financing and marketing, and is more likely, therefore, to develop scientific management before the larger and more confident concern considers it necessary. The early user of scientific management pays presumably the same rent and interest as his competitors, and although he pays somewhat higher wages on account of the bonus, his cost per unit of product is less, and his selling price may be and often is the same as theirs. He therefore gets a considerably higher return and has a notable differential advantage over all his competitors. If his large-scale competitors are approaching, or have already passed, the

point of negative returns[1] and are not themselves using scientific management, his advantage may be great enough to enable him to maintain his position and even ultimately to drive his larger competitor out.

In the mean time the advantages that the early user has tend to make him, at least to some degree, independent of local physical disadvantages where such exist, as in New England. It is significant that a proportionately larger number of manufacturers in the New England States are using scientific management than in any other section of the country. The disadvantages of a location in a remote corner of the country, far from the sources of raw material, must be overcome by superiority of management. The same course of reasoning applies to relative international advantages. The absence of artificial props, such as a protective tariff, may and in fact must be compensated by the development of higher efficiency of production. The fact that the advantages now derived from scientific management are temporary in their nature, so far as these considerations are in-

[1] By "point of negative returns" is meant the point at which the disadvantages inherent in any development, whose gradual offsetting of advantages in such development constitutes "diminishing returns," have overwhelmed the advantages so that further growth returns less than its cost.

volved, does not detract in the least from their present value.

These differential advantages persist until all plants have adopted scientific management — a contingency which in the nature of things is not likely to occur. The manager of the scientifically managed plant may sell at the price set by the poorest and most inefficient producer whose output is still needed to meet the demand. If he wishes to expand, however, he will cut under this price, thus increasing the sale of his own product and driving the inefficient producer out of business. The margin thus tends to recede toward the more efficient producers. If this tendency were to go on unimpeded, eventually there would be none left except those using scientific management. For various reasons, however, this is certain to be a slow process.

If the fact of diminishing returns in industry finds its origin, as I believe it does, in the gradual development of the inherent disadvantages which accompany the advantages of any industrial growth, it is pertinent to inquire whether the positive type of organization is not itself subject to this apparently universal law. I believe that it is.

The development of the science of industrial

conservation goes on apace in its early stages because the returns from research and investigation, even when so expensive as those carried on by Mr. Taylor, far outweigh the cost. As these results are incorporated in current practice the research must be pushed farther at an ever-increasing cost and in many cases with a relatively decreasing return. This is illustrated by the fact that a consulting management engineer is perfectly satisfied to get ninety per cent output from a machine. He could, in many cases, run this up to ninety-five per cent or even higher, but the cost of the last ten per cent often exceeds its value.

A similar consideration applies to the development of control in administration. The advantages of centralized planning department control are clear enough in the early stages. There appears to come a time, however, when the increase in supervision, clerical work, and printed forms, required for ever-closer control, costs more than it is worth. It is difficult to say just where this point of negative returns is reached, but that it exists cannot be questioned.

Both these tendencies to diminishing returns are constantly being offset by the steady flow of invention which accompanies the development

of scientific management. Every time-and-motion-study-man is an inventor. Minor improvements are constantly being made in the technique of mechanical processes and of clerical work. That they have been worth more than they cost is in general evidenced by the fact that they continue in use. It is impossible to predict how long this flow of invention will persist or how far it will go. The one certainty is that there is no end to it yet in sight, and only by its continuance can the point of negative returns be indefinitely postponed.

One respect in which scientific management tends to hasten the onset of diminishing returns in organization itself is in its policy of increased specialization. The intensive attention to production forces similar intensive application to financing and distribution. At the same time there must be closer adjustment of production to the requirements of the market, of marketing to the capacity of production, and of financing to the needs of both. Increased specialization is accompanied, therefore, by closer interdependence; and the only solution is more highly centralized control. Such control demands an increasingly higher grade of managerial ability and enlarges the risk of failure. The exception principle tends to postpone the full de-

velopment of this tendency, but it persists none the less, and unless some other method of counteracting it is evolved, it will eventually automatically put a stop to the extension of centralization.

It would be interesting to speculate on the bearing of these considerations on governmental control and on the theory and proposals of socialism; but this would lead us quite beyond the limits of this chapter. I will be content with suggesting that the objection to government control of various degrees up to and including a completely socialistic state, on the ground that the increasing magnitude of the operations involved is beyond the capacity of the type of managerial ability now at our command, loses somewhat of its force if the type of organization here described could and would be applied; although, in this connection also, the inevitable incidence of the law of diminishing returns must be kept in mind. It is interesting to note that scientific management has been made an object of special study and investigation by the syndicalist leaders in Italy, doubtless with an appreciation of its bearing on the fundamental principles of their movement.

Thus it appears that the tendency of scientific management is to enlarge the supply of man-

agers and increase the value of the trained and professional administrator. While this may aid the development of large-scale industry by postponing the point at which negative returns will appear, in the case of those industries which utilize the system, the present tendency and indications are that the smaller-scale plants are using scientific management first and are thereby strengthening their competitive position. The differential advantage which early users of scientific management have tends to overcome, at least temporarily, local disadvantages under which they may labor.

This advantage tends slowly to disappear as an increasing number of plants adopt scientific management, partly because the differences are equalized and partly because of the development of a condition of diminishing returns in the application of scientific management itself.

II. Scientific Management and Labor

The most interesting questions connected with the effect of scientific management on the labor problem are: first, its influence on basic wages; second, the probable consequences and effect of the method of differential payment by means of the bonus; and third, the relation of

scientific management to fundamental labor union policies and practices. These will be taken up in order.

1. The Influence on Basic Wages

Scientific management tends to shift the demand from labor which is already skilled to that which is teachable. It draws its labor supply not so much from those equipped with the usual store of traditional knowledge and technique as from those with the aptitude which enables them to respond quickly and effectively to the intensive training in the newer methods. The effect of this tendency would be eventually to abolish the line between "craft" groups. Factory labor may to-day be arranged in a hierarchy of day laborers, "lumpers," automatic machine tenders, helpers, skilled machinists and artisans, foremen and clerks. Scientific management as actually practiced trains each of these grades in a variety of functions usually performed by other grades. Thus laborers may easily become truckmen. Truckmen may at a pinch attend the simpler automatic machines. Machine tenders are easily made into helpers, and helpers into skilled artisans. The class of foremen and of clerks is almost invariably recruited in scientific management

plants from the better men in the lower grades of labor.

The characteristic functionalization in the executive positions opens these positions to types and grades of ability to which they have heretofore been closed. Specialization puts these positions within the range of men who are competent in executive functions such as "getting work through," inspection, or breaking in new operatives, and has made obsolete the type of all-round ability (much written about but rarely found) which was erroneously supposed to be a requisite of the old methods. More lines of promotion are thus opened and the demarcation between the workmen and executive groups tends still further to be obliterated.

In short, the effect of these features of scientific management is to break down the traditional lines between craft groups while at the same time they develop individual differences and individual abilities to the utmost and thus establish a new grouping on the basis of inherent and acquired capacity.

Some economists would say that the abolition of craft groups would not only tend to level wages by increasing the homogeneity of labor, but to lower them on the whole by extending

the marginal zone which they say is the controlling factor until it includes a lower grade of efficiency and productivity. Such perhaps would be its effect in practice were the tendency not offset by certain counter-tendencies.

The first of these is the greater productivity of labor in the new grouping due to the positive methods of scientific management. This makes all grades of labor more desirable for the *entrepreneur*. Or, if you prefer to put it that way, it raises the value of the marginal workmen.

The tendency to increase the number of *entrepreneurs* is an aid in the maintenance of higher wages by intensifying the competition between them for labor.

The thoroughgoing development of differential abilities in individuals within groups clearly brings out inherent differences in effectiveness and value which are more or less obscured by current methods of measuring the worth of workmen. Considered as "capital" on the analogy of instruments (made by man) and land, the "rents" for their differential abilities are more clearly brought out, and the capitalized value of each workman is more easily ascertained. As the more keenly competitive utilization of land has on the whole tended to raise the total amount paid to owners as rent,

so it would seem fair to assume that the keener competition for workmen and the clearer differentiation in their worth should tend to increase the total amount paid to them as wages.

The same differences in inherent capacity which tend on the whole to raise the total of wages also tend to maintain the higher wages paid to the more able individuals, inasmuch as the differences which under scientific management conditions are important are natural, inherent, and practically ineradicable.

If these propositions are true we can proceed to the familiar chain of reasoning to the effect that increased wages tend to raise the standard of living and with it to decrease the size of families. This in its turn decreases the supply of labor, which, assuming that its product remains the same or even increases, raises its value. In this way also exceptional opportunities are afforded to children for still further development of inborn abilities and accentuation of differences. The net effect of all these is the maintenance and progressive raising of wages and the standard of living, with their mutual and cumulative reactions.

To-day it is probably true that the relative disagreeableness of different kinds of work has little if anything to do with the rates of wages.

Those rates seem to be determined by a number of forces, among which customary standards, such differences of ability as may become apparent under current methods, and the relative bargaining powers of employees and employers are the controlling factors. The abolition of artificial "non-competing groups" and realignment on the basis of lines of individual ability tend to accentuate differences of wages due to relative efficiency and would thus seem to give more scope to the influence of relative sacrifice, effort, or disagreeableness. Too much importance must not be ascribed to this possible effect. It is mentioned here because it is in general agreement with what, as will be shown later, appears to be the more or less unconscious wage theory of those most active in the origination and early development of scientific management.

2. The Bonus Method and its Results

Most of the current discussions regarding the relation of scientific management to wages center about the payment of a bonus or premium. It is customary in scientific management to offer a premium of some sort in addition to ordinary wages for the performance of the extraordinary day's work prescribed in the task or

schedule made possible by standardized conditions. This is justified on the ground that it is "fair" to pay an unusual wage for an unusual day's work; that it is necessary in order to get the workman to accept and utilize standard conditions; that it is possible because of the superior profits of the *entrepreneur* using scientific management; and that it is a just recognition of superior qualities. In other words, it is justified by its advocates, no matter by what ethical theory of wages it may be tested.

There are those who question the justice of the basis on which the bonus is determined. That basis is roughly the lowest point at which the workmen will consent to accept and utilize the standardized conditions provided for them and thereby accomplish the task set. Experience has shown that for the majority of men and in average conditions this requires a bonus ranging from thirty per cent to about sixty per cent on the ordinary day's wages. They will not attempt to do the task for less than this nor is it necessary to offer them more.

But is this a fair compensation for an increase of output amounting as in some conspicuous instances to two or three hundred per cent? Ought not this increase to be shared equally with the workmen, or even, as some have put

it, to be turned over entirely to them? What should be done in the cases, almost as numerous (except in machine shops), where the increase in output secured is less than the bonus paid and the bonus is adhered to merely in the interest of consistency or because it aids some other feature of administration, has not been suggested. At least I have seen no proposal that the workmen be asked to accept a lower bonus on that account; nor in fact is there any likelihood that such a proposal would be accepted.

That the increased output due to the application of scientific management cannot be credited exclusively to the efforts of the workmen should go without saying; and the theory that the workman is entitled to all the increase regardless of the expenditures of the management necessary to make this increase possible does not call for serious refutation. The basis for the division at any amount less than the entire increase must be either that of necessity, which may be ascertained by test, or that of some hypothetical "fairness" about which there is no substantial agreement. The test of necessity therefore has the advantage of being practicable and easy to apply.

Without going into a discussion of the bases

of social ethics, I merely state my belief that justice and fairness are essentially terms for social expediency. In order to secure the exercise of high managerial ability and initiative it seems necessary, as human nature is now constituted, to insure some certain and exceptional reward to the *entrepreneur*. Unless the manager gets what he considers a sufficient share of the increased productivity due to positive management he will not undertake the expense and risk of developing the system. It is necessary, and therefore expedient and just, that his share of the profits be at least sufficiently large to make it worth while, in his own opinion, to undertake this measure of progress.

Another question, often urged with critical intent, is whether, when the present extraordinary day's work becomes common and ordinary, the payment of the bonus will continue to be necessary. In other words, when all plants have scientific management, will not unscrupulous managers be in a position to cut wages to their present levels and to use their knowledge of a proper day's output as a more subtle, refined, and effective method of driving?

As long as some plants have scientific management and others have not, those which have it can maintain their advantage only with the

willing coöperation of the workmen. Scientific management does not work except with the heartiest consent and help of the men under it. To maintain this attitude it will continue to be necessary to pay the unusual day's wage for the unusual day's work. With the establishment of an ever higher standard of living, the practical necessity of maintaining the differential reward for differential abilities becomes increasingly stronger.

It is conceivable though hardly probable that all plants will some day have scientific management. The process of development is slow, due to a number of causes which will be explained later. Further, it is contrary to all historic evidence to suppose that any tendency may be permitted to work itself out to its own ultimate conclusion unrestrained and unmodified. Every movement involves in itself certain countertendencies whose force sooner or later become so great as to overwhelm the original tendency. This is the meaning of the "law of diminishing returns," taken in its broadest sense.

If these considerations are not sufficient to obviate apprehension, attention may be called to the fact that if all plants should have scientific management the worker's protection

would continue to reside in two forces: first, the dependence of the manager on the worker's good-will; and second, the individual and organized opposition of the worker to any substantial reduction in his standard of living. Only those familiar with scientific management in operation can appreciate how vitally necessary to its successful conduct is the spirit of willing, cheerful, and contented coöperation. The mechanism of scientific management is delicately balanced and may be completely upset by the intrusion of a feeling of unfair treatment. If this protection should prove insufficient, the workman will still have the force of established custom behind him, and in addition the power which his membership in a union, in unionized trades, will continue to give him — that is, provided some basis may be reached on which scientific management and labor unions in their present form may survive together. If there is no such basis (a topic which will be discussed presently) the chances are that labor unionism, at least as it is now organized and conducted, will disappear; but there will still remain the possibility and perhaps the need for some more truly representative and progressive type of labor organization.

Another question often put by inquiring

critics is whether the increase of output made possible by scientific management does not or would not go on faster than the market can assimilate, thus leading to the wholesale discharge of superfluous employees. By way of analogy reference is made to the sufferings of the chain workers, weavers, and others, and the general distress which accompanied the substitution of power-driven machinery for hand-operated tools. No very close analysis of this historic episode is usually attempted in an effort to determine just what part the introduction of power machinery did actually play in the economic disturbances of the first half of the nineteenth century and what share should properly be attributed to the Napoleonic wars and other political conditions. It is said, however, that after all due allowance is made for other factors, one effect of the sudden introduction of labor-saving machinery was to throw large numbers of workmen out of their positions and to increase materially the total of suffering. Is there anything about scientific management to make one hopeful of more satisfactory consequences?

The development of scientific management is not parallel to the introduction of power-driven machinery. Machinery is something

which can be bought in large quantities, installed and operated on short notice. All it requires is a large market for its product, an investment of capital, and a brief training in its operation. Scientific management is a type of organization and a set of principles which must be slowly developed, can be used only by those mentally prepared for it, and during the period of transition and adjustment can be had only from a few individuals whose time and energy are limited. It involves on the part of the management a mental revolution and on the part of the workmen a gradual habituation to new methods.

The number of men capable of developing the system is limited, and on account of the peculiar abilities and opportunities required for the successful prosecution of scientific management as a profession the number of its practitioners has not increased very rapidly nor is it likely to in the near future. Only slightly more than one per cent of the plants in the United States large enough to warrant its development have undertaken it and in no instance has their increased product been placed on the market before the market was prepared to take it up without disturbance.

Instead of throwing men out of work it has

thus far meant the more steady employment of forces in plants where it is used. There has been some redistribution of positions. There has been no reduction on account of scientific management in the number of those employed; on the contrary, there have been actual increases recorded. It is safe to say that the displacement of workers which may later be possible with the more rapid spread of scientific management will not be comparable in extent and influence with that already experienced in consequence of the access of women to men's occupations which has been characteristic of the last half-century.

In order to reduce to a minimum the unavoidable redistribution due to the new methods, it is a policy of scientific management, thus far consistently adhered to, to insist on the development of sales in advance of the increase in production. This may be accomplished by any one of several methods whose net result is to maintain even employment by spreading production of seasonal commodities over the entire year and to take up the increase in the productivity of men and machines by putting an article of superior quality or lower price before a larger market. Although the practitioners of scientific management have not themselves

as yet given much attention to the problems of marketing and distribution, some of them have pointed out the necessity of developing this field and by their insistence have secured practical results in the way of better methods and larger sales.

It is a truism that in the long run production at lower cost per unit tends, after due allowance for economic friction and variations in elasticity of demand, to reduce the selling price of the product and thus to stimulate demand and to take up the slack due to increased productivity. For a product subject to an elastic demand, this would come about automatically in an intelligently self-interested and freely mobile economic society, such as we do *not* live in. In our present state of development intelligence is sometimes overcome by ignorance or inertia. Self-interest may be so personal as to override itself and free mobility is hedged in by innumerable barriers physical and social. With conditions as they are, the tendency to an automatic increase of demand in response to production at lower cost must be stimulated by consciously directed effort to extend the market and to reduce the cost of distribution.

It is no reproach to the present group of prac-

titioners in scientific management that they have not attacked and solved the problem of distribution. They have had all they could handle in the problem of production. But it will soon become a reproach to society if the principles which have been so fruitful in production are not studied, mastered, reshaped and applied to the problem of distribution.

A criticism frequently aimed at scientific management is that its methods tend to destroy the skill and initiative which are alleged to be the capital of the workingman, thus making it more difficult, if not impossible, for him to maintain his position or advance out of his class. The most superficial observation of plants in which the methods of scientific management have been fully developed must convince any fair-minded investigator that the criticism is not sustained by the facts. On the contrary, in such plants the skill of the workmen is on the average far above that of their fellows in other establishments; and so far as their capacities enable them to participate either in technical advances or in the exercise of managerial functions, their opportunities are better and more freely utilized in scientific management plants than elsewhere.

In the nature of scientific management it

could not well be otherwise. Increased production is secured by superior skill, that is, by better acquaintance with the materials, tools and methods involved and greater dexterity in their manipulation. This is due to two fundamental principles: specialization, making possible a high degree of attainment in a more varied field; and intensive individual teaching of scientifically ascertained methods, developing the capacity of the workmen to its utmost limit.

Unfortunately skill is still sometimes confused with variety of attainment. There is a notion that the "all-round" machinist is a skilled machinist. The ability to do a good many things in a trade half well is apt to be considered better evidence of skill than the ability to do a few things perfectly. The contrary is the fact. The methods of training characteristic of the scientific type of management provide the workman with a measurable and demonstrable skill, one of the effects of which is to tone up his standard and make him dissatisfied with a hazy versatility which is unaccompanied with real skill in any detail. With such a standard the workman with inventive ability is enabled in the first place to reach the stage of attainment at which alone invention is worth while, and in the second

place to distinguish with accuracy of judgment what invention is useful and practicable rather than merely novel and ingenious.

Initiative, both in invention and enterprise, is found in widely varying degrees. In invention, initiative of the lower grade is if anything all too common. In the vast majority of instances invention proceeds by very short steps from the known to the guessed or desired, and is within the capability of any one who will take the trouble to familiarize himself with the immediate problem in hand. This is being encouraged and practiced every day in scientific management plants. It is desirable when it leads to improvement, otherwise it is a mere hindrance; and it is about as likely to be one as the other. The higher type of invention which comes out of the blue, as it were, is extremely rare and is epoch-making in its manifestations. It is the mark of genius and is not affected by any such factor as a type of management.

Initiative in the sense of enterprise is comparatively rare. Its possession in even a moderate degree distinguishes the *entrepreneur* from the workman; its presence in highly developed form marks off the daring merchant or captain of industry or of finance from the humdrum manager of a routine business. The

tendency of positive management is to provide unusual opportunities for the exercise of both types of initiative and therefore to encourage its manifestation.

Those whose professional interests cause them to be opponents of scientific management, and some of their philanthropic and academic sympathizers, are fond of alleging that it is a speeding-up device injurious to the health of the workmen. Extensive and frequently repeated investigations have thus far failed to reveal anything to substantiate this criticism. On the contrary, the beneficial results which might be expected to follow from increased wages, steady work, improved working conditions, conscious attention to the fatigue factor, individual training, and the necessity of fit physical and mental condition, all of which are essential to the accomplishment of the task as set by scientific management, have been found in fact to follow. The whole aim of scientific management is to substitute intelligent economy of effort for unintelligent driving, and such has been its practice. When its critics, confronted with the facts, resort (as has one, at least, to my knowledge) to something in the nature of an intuitive belief that in spite of appearances scientific management in some

way injures "global efficiency," whatever that may be, it is evidence of the survival of a metaphysical stage of thought into an atmosphere of scientific determination.

The emphasis laid by Mr. Taylor on the value of the "first-class man" has misled many people into the impression that the Taylor System can find no place for any but the exceptionally capable worker. This is due partly to a failure to grasp the meaning of Mr. Taylor's phrase "a first-class man." In scientific management a first-class man is one who is adapted to the job he is doing, whether it be digging a ditch, tending an automatic machine, acting as inspector, running a plant, or organizing a combination. By applying intelligence and discrimination to the selection of men to fit the individual case and the attention necessary to train them to the most effective handling of their jobs, scientific management aims to make every man a first-class man. It must be said that in practice this has often been the result actually achieved. Obviously this is a very different thing from the selection of the exceptional man and the rejection of the average. It amounts to the development in the average man of an exceptional fitness for his job.

This process has an important bearing on the questions revolving around the employment of the subnormal and the application of minimum wage legislation. At present the weak point in minimum wage legislation is the fact that an employer cannot be expected or compelled to employ people who are not able to earn the minimum wage prescribed. Where that wage is fairly high, such, for instance, as has recently been established in the brush- and candy-making industries in Massachusetts, it tends to the elimination of all except those who by superior capacity and knowledge have raised themselves up to and beyond the point at which they earn that wage. The employer has the alternative either of dropping all not yet up to that point or of training them so that they are worth the minimum set. Scientific management has shown the possibility, the advantage and the method of such training. It points clearly and demonstrably to the solution of the problem how to meet the interests of the employees, the employers, and the general public at one and the same time through minimum wage legislation; namely, by the development of the efficiency of plant, equipment, and employees up to and beyond the point where the minimum wage is recognized as a reasonable and possible standard.

The superiority of the results attained by scientific management on account of its closer, more centralized, better harmonized, defined and trained organization as compared with the looseness of household and domestic industry points to a new means of combating the sweating evil. The sweated industries are the happy hunting-grounds of the traditional driver. Scientific management has demonstrated that applied science and the system of industrial principles based upon it produce results greater than those which follow from driving methods; and this has been demonstrated in the garment-making industry, heretofore notorious for its sweating methods. These results, it need hardly be said, can be secured only under centralized factory conditions.

The methods of scientific management also have a bearing on the employment of women and children. Whether the remarkable increase in the employment of women in recent years is a necessary evil or a blessing in disguise is not altogether clear. That it has resulted in grave social loss, both through the physical injury to women and to motherhood and also through the cutting of wages in competition with men, cannot be denied. The tendency of scientific management is to ameliorate

to some extent both these harmful consequences. In its regard for the physical fitness and welfare of its employees, it is less likely to develop or tolerate practices whose effect may be personally and physically injurious. In its accurate determination of individual ability and its payment of wages in proportion to the ability thus determined, it reduces the possibility of unfair competition between the sexes. Whether a woman is doing as much work as a man is a question which may be answered objectively and scientifically instead of metaphysically as is the present tendency. Whether women are entitled to equal pay then becomes a question of fact.

Similar considerations apply in even greater force to the work of children. The evil consequences of that work are greater and more indisputable even than in the case of women. On the other hand, its inefficiency relatively to men's work is much more obvious. Scientific management has already shown in many cases that it does not pay to employ children. It is thus in a position to reinforce, from the "practical" business point of view, the advocates of child labor legislation, whose arguments are usually based on more general social considerations.

3. Labor Unions

Until recently the problem of the relation of scientific management to organized labor had, as one of its practitioners said, "merely an academic interest." There was no attempt to develop the system in closed shops. In other shops no one inquired or knew whether there were union men or not; nor, if there were such, did they offer any objection to the development of scientific management. About 1910, however, or even earlier, in some of the railroad brotherhoods, the attention of professional labor leaders was directed toward the possibilities of this type of management. Their reaction was unfavorable; but except for the refusal of locomotive engineers to accept the bonus proposals on the Santa Fé Railroad, no opportunity to express their organized opposition to scientific management presented itself until that system was extended to a detail of the Watertown Arsenal, which is part of a highly unionized branch of the government service. This was seized upon by the leaders, apparently without regard to the real feelings of the men or the facts in the case, as the occasion for a brief and insignificant strike and a long train of government investigations, reports, petitions,

and bills in Congress, whose aim is to discredit scientific management generally by setting on it the stamp of governmental disapproval. In the last Congress this agitation was successful. The affair has been of sufficient importance to convert the question from one of academic interest to one of general industrial and economic consequence.[1]

The traditional attitude of the practitioners of scientific management is based on strong practical considerations of which they are fully cognizant, and on an economic theory which is rather implicit in their discussions. In general they admit certain historic advantages in trade-unionism, such as the gradual shortening of hours, the improvement of working conditions, and the maintenance and raising of wages. They admit that labor organization is still necessary to secure and maintain these advantages in plants not using scientific management. But they insist that scientific management provides these advantages to the workingman more quickly, more certainly, and in fuller measure, than the labor organization ever has done or can do. Reduction of hours is a not uncommon practice under scientific manage-

[1] As is recognized by the fact that the United States Chamber of Commerce has appointed a committee, in response to this agitation, to investigate the subject once more.

ment. The standardization of conditions to the point of economic perfection is a fundamental principle. Wherever scientific management prevails, basic wages are maintained as a matter of expediency, and are raised by the extent of the bonus. These results are brought about quickly, and without dispute or trouble. Why then, they ask, is labor organization necessary?

The advocates of scientific management do not stop, however, with this negative position. They maintain that certain of the present principles and practices of labor unionism are not only incompatible with the fundamental principles and practices of scientific management, but are subversive of the public interest. This criticism applies to such practices as restriction of output, insistence on a uniform wage, collective bargaining on matters which are questions of fact rather than of opinion, restriction of membership, and the closed shop.

Socially controlled restriction of output may under some circumstances be advisable, as when there is regulation of the acreage to be sown in wheat or cotton or of the amount of coal to be mined year by year. The movement for the conservation of natural resources is a form of restriction enforced in the broad public interest. This is an essentially different

matter from privately controlled restriction, whether by the *entrepreneur* or the workman. Such restriction may be of temporary advantage, maintaining profits for a while for the *entrepreneur* and possibly maintaining wages and postponing unemployment for a while for the workman. Both these results, however, are temporary and of individual benefit. Scientific management aims fundamentally at the increase of the national dividend, which any form of privately controlled restriction aims to reduce. Scientific management, while recognizing that overproduction may occur as an accidental result of uncoördinated industrial activity or of the friction and groping of distribution, denies the possibility of real overproduction in the sense of an excess of consumable goods over the needs of society. Scientific management opposes the lump of labor theory, and insists that the more economically work can be done, the greater will be the demand for it and the more highly rewarded the workers. And there is no question that increased production at lower cost per unit is desirable, at each successive stage, from the point of view of the *entrepreneur* producer.

Although labor unions are becoming less and less willing to acknowledge restriction of out-

put as a fundamental policy, there can be no doubt that such restriction is their constant practice and that in the back of their heads it is their final answer to the problem of unemployment. For the individual workman in the individual plant much is to be said for their theory. If the plant has orders for a hundred units, the men's jobs will last ten times as long if they take ten days instead of one day each per unit. The broader social consequences of this type of restriction work out slowly and react only in the most obscure ways on those who practice it, while its immediate personal consequences are obvious and apparently advantageous. Even if the workman sees the ultimate social disadvantage of this policy, he can hardly be expected to sacrifice his present personal advantage to a remote social good.

Inasmuch, however, as one of the fundamental aims of scientific management, and a necessary result of all its practices and methods, is the increase of output, there is here, in the absence of centralized social control of production, an irreconcilable conflict. It would appear that the ultimate social as well as the immediate industrial advantage is on the side of scientific management, and that, as it cannot surrender its fundamental principles, it

must continue to educate society to the advantages of large output and to fight all efforts to restrict it.

There is an equally fundamental conflict between the trade-union principle of a uniform wage based on class similarity and the scientific management principle of a differential wage for differential abilities.

Scientific management accepts the wage current in the community as its basic wage, and so long as general conditions remain substantially the same, considers that this wage should be paid uniformly to all workmen for an ordinary day's work. Some of its practitioners may question theoretically the justice of these current rates. While their theories have apparently not been thoroughly reasoned out nor stated with any great clearness, there appears to be among them a feeling that basic wages should be related to each other in proportion to the disagreeableness, sacrifice, or "cost" of different occupations, scientifically determined. One proposes that this determination shall be on the basis of foot pounds of energy expended, another on an estimate of the relative total disagreeableness or irksomeness of jobs. These theories are not pressed very insistently, however, nor is there much tendency to ques-

tion the justice of the current rates. On the whole they are felt to depend upon some rather hazy "law of supply and demand"; and in any case the validity of this law, if there is any, is outside the practical scope of a scientific manager's business. He accepts current wages as they are, as the basis on which to build a differential payment for differences in ability.

For on the theory express or implied that wages should be proportionate to productive efficiency, it is agreed among all scientific management experts that it is both just and necessary to pay more than an ordinary day's wage for an extraordinary day's accomplishment such as is made feasible by their methods. It is necessary, as already explained, because otherwise the workmen will not perform the unusual day's work. It is just, because it tends to encourage the exercise of superior abilities to the ultimate benefit of society; whereas a uniform wage tends to reduce the effort of all men, whatever their capacity may be, to the level of the least efficient man who receives the uniform wage. There is also a feeling, scarcely reasoned out or defined, that the workman should in some way share in the increased product secured at least in part through his efforts. In any case there is a thorough con-

viction that differential wages are essential to the practice of scientific management and that therefore the trade-union principle and practice of uniformity is absolutely unacceptable.

The objection of scientific management to collective bargaining rests theoretically on the incompatibility between bargaining and the accurate scientific determination of facts, and practically on the numerous difficulties thrown in the way of the reorganization of a plant by recognition of labor unions as at present led and conducted. Scientific management endeavors to build up the principles of industrial organization as well as the science of industrial conservation upon a basis of ascertained fact, where possible; and it declines to admit that any facts pertinent to the discussion are not ascertainable. Bargaining implies difference of opinion and compromise until a basis of agreement is reached. You do not bargain about or vote on scientific facts. If the ideals of scientific management are realized, therefore, the field left open for collective bargaining is narrowed to those matters which cannot be, or at least have not been, reduced to law.

In the opinion of some this eliminates altogether the possibility of collective bargaining; for they believe there is no factor, not even the

basic wage rate, which cannot be reduced to accurate scientific determination, even if such determination is only the resultant of an unanalyzed "law of supply and demand." Others (of whom I am one) believe that while the basic wage rate is doubtless determined by some law, natural or social, the law has not yet been accurately and comprehensively defined; and that therefore, theoretically at least, the basic rate of wages may be a subject of bargaining. But there is complete agreement that such matters as the process to be used, or the time which it should take to perform a given piece of work, and the amount of bonus which is to be paid for its performance within a standard time, are questions of fact, and therefore not in any sense subject to collective bargaining.

More important, however, than the theoretical consideration is the circumstance that collective bargaining under existing conditions requires a recognition of the union and thereby brings in its train a series of difficulties and conflicts which might be avoided altogether by consistent refusal to deal with organized labor. The bargain on basic wage rates, even though theoretically consistent with scientific management, does in fact involve many details of organization such as the length of the work-

ing day, the employment of men or women or children, and the determination of what constitutes the (customarily ordinary) day's work. Further, such a bargain opens the way to "dickering" over many other details, such as the degree of specialization to be required, the functions and authority of minor executives, the principles governing inspection, and the reduction of defective workmanship. All scientific managers will testify that at best the difficulties of their work are extreme, not to say heartbreaking. To complicate them with the necessity of conferring with committees of workmen, not in the slightest degree familiar with the principles of management or the details as they are being worked out in the plant under process of systematizing, would be well-nigh fatal.

To this difficulty must be added the well-grounded fear of abuse of the striking power of organized labor. Whatever may be said in favor of the strike as a weapon to secure, under the current types of management, the reasonable demands of the workmen for shorter hours, higher pay, or better conditions, it is difficult, if not impossible, to justify the sympathetic strike, and its even worse variety, the strike that grows out of jurisdictional disputes. The

manager, who by reason of his standardization of conditions, payment of higher wages, fair treatment of his employees, and development of a type of organization which renders jurisdictional disputes almost meaningless, has removed practically all the tenable grounds for striking, is justified in his fear of mere sympathetic and jurisdictional strikes.

The manager's aversion to recognizing a union is still further intensified by his distrust of the type of leadership which is characteristic of much of American labor organization to-day. Even its friends must admit that the American Federation of Labor is governed and controlled by a type of leadership marked rather more by political ability (in the objectionable sense) than by a broad-minded, socially trained public spirit; and one may even question whether it displays a keenly intelligent and sympathetic interest in the ultimate welfare of the workingmen. The proceedings of its national conventions are often marked by a short-sighted selfishness and disregard of social considerations which is the mark of the self-seeking politician. It is said, and it is doubtless true, that exceptions must be made to this general judgment of current labor leadership; but that it is substantially accurate cannot be denied by any

one who is more interested in the ascertainment of facts than in permitting the substitution of a good intention for an unfortunate reality.

A great many union men are now working in scientific management plants. The organized complaint against this system which has had so much publicity comes from an insignificant fraction of the union men actually working under it, and there is at least reasonable ground to believe that the real feeling of even that fraction is misrepresented in the complaints officially emanating from them. If this is true, it is but a testimony to the fundamental reasonableness and intelligence of the average workingman. The practitioners of scientific management have every means of knowing and have always insisted on a recognition of this native reasonableness; and if it could always be found in the same degree among the "leaders" who would represent these men on committees for purposes of collective bargaining, the present unwillingness to consider even the possibility of such bargaining would rapidly disappear. Under existing conditions, however, every day's experience provides additional practical arguments against collective bargaining.

The labor-union policies of restriction of membership, limitation of apprentices, and

the closed shop, are all, as at present practiced, contrary to the principles of scientific management, for reasons too obvious to call for discussion. The principle of organization on craft lines, as exemplified in the American Federation of Labor, is also incompatible with the tendency of scientific management to substitute a classification of labor on the basis of efficiency and teachableness for a grouping on the basis of trade or occupation. This tendency is in fact the most irresistible weapon that scientific management now opposes to the current type of labor organization as represented in the American Federation of Labor. To those intelligent enough to distinguish the real principles of syndicalism from its crudities it will be apparent that the I.W.W. represents more modern tendencies and, unless it is killed by its abuses, has a more promising future (partly because of its greater consonance with the principles of scientific management) than the American Federation.

In the light of this discussion it would appear that scientific management in its present form and organized labor as represented in the American Federation in its present form cannot persist together. One or the other must be modified. If history may be relied on to repeat

itself, it is safe to prophesy that scientific management, on account of its superior economic advantages, will compel the revision of labor organization, while itself not entirely escaping the necessity of some modification.

It is conceivable that labor organization may shift its basis from restriction of output, uniformity of wage, and restriction of membership to an acceptance of the principles of maximum output, wages in proportion to ability, and freedom of membership, while still retaining its fundamental and necessary power to help determine the minimum wage rate and the minimum working conditions through the instrumentality of some mechanism in the nature of a collective bargain. If bargaining is, as I believe, the determining factor in the establishment of the basic wage within certain limits, there will always be a need for organization of employees to enable them to offset by their combined strength the strategic advantage of the employer due to his initiative in hiring and his control of the purse-strings. The features of current trade-unionism objectionable from the point of view of scientific management and, as I believe, from the social point of view, are unnecessary to the existence of labor organization in the interest of the maintenance of minimum

rates and conditions. Furthermore the labor politician in his present stage of evolution is not only unnecessary, but is an active detriment to the fulfillment of the best purposes of labor organization. For the development of collective bargaining on a basis of fact instead of compromise of opinion, labor organization must secure and maintain a radically different type of leadership from that which it now has. To this end all it has to do is to scrutinize its present leadership carefully, appreciate how misrepresentative and misleading some of it actually is, and substitute for that element a genuinely representative leadership that is law-abiding, fair in intention, socially minded, honest, intelligent, and interested in the permanent welfare of its constituents.

On the other hand, as scientific management extends from the plants which are entirely non-union shops, or are at least open shops, to those in which unions are strongly organized or even dominant, it will be incumbent upon it to recognize the necessity of some kind of coöperation. Even if this universe is as deterministic as some exponents of scientific management insist,[1] the laws governing social and

[1] See preface to the French translation of Taylor's *Shop Management*, by Henri Le Chatelier; reprinted in Thompson's *Scientific Management*, p. 842.

economic relations and the interaction of individuals on each other are not yet formulated; and until they are, there must remain a place for bargaining. Scientific management must recognize also its twofold character as a collection of laws on the one hand and as a set of principles on the other. The laws of science are not determined by counting heads; but principles of conduct in a free society can be enforced only by the consent of those affected. If this consent requires the coöperation of organized labor, so be it, provided this coöperation does not involve the sacrifice of fundamental industrial and social principles.

Scientific management, in spite of some of the claims of its more enthusiastic advocates, is not an industrial panacea. It cannot put an end to industrial unrest so long as personal and economic friction and inequality of income and opportunity persist. It is well that this is so, for complete content would be stagnation. On the other hand, scientific management does narrow the field of unrest and tends to refine the methods by which discontent makes itself audible and effective. It clarifies the issues between labor and capital, makes them more definite and more closely circumscribed. This process reduces the number of possible dis-

putes and at the same time increases the possibility of arbitrating those that are left. In the long run this means less warfare and bitterness and more substantial justice to both sides.

Some time ago I suggested that the labor unions in their own interest should advocate and compel the adoption of scientific management in those plants in which they could make their influence most felt.[1] I have since come to the conclusion that this is utopian. Before it can be done there must be a new type of leadership, and those policies of organized labor which are incompatible with the fundamental principles and practices of scientific management must be abandoned. Further, the necessary unanimity of action on the part of all trades in a plant can be secured only by the "industrial" type of organization — represented perhaps by the I.W.W. — not by that exemplified in the American Federation of Labor.

I still believe, however, that the tendency is in this direction and that it can only be postponed and not diverted by the active opposition of labor leaders and by public interference such

[1] See C. B. Thompson, "The Relation of Scientific Management to the Wage Problem," *Journal of Political Economy*, vol. XXI, p. 630. Reprinted in Thompson, *Scientific Management*, p. 796. Cf. Croly, *Progressive Democracy*, pp. 399 *ff*.

as was attempted in recent congressional legislation. In the long run the effect of such interference is helpful to scientific management because of the publicity given it and the evident importance attached to it even by those professionally opposed. In industry, as in religion and politics, there is nothing like persecution to aid a cause which is inherently good.

III. Larger Social Problems

What progress has scientific management made or is it likely to make toward the solution of larger problems, such as the cost of living, the reduction of unemployment, the improvement of education and skill, the smoothing out of inequalities of income, and the development of democracy in industry? Its originators and advocates claim the solution of these among its fundamental aims. It is altogether too early to give a just appraisal of its actual effect on such matters; but it may be advisable to consider just what scientific management does contribute toward the complex of factors bearing on them.

It would be difficult if not impossible to show that scientific management has as yet contributed materially to a reduction in the cost of living, at least so far as that may be evidenced

by a reduction in the price of those articles and items which go to make up the cost of living. It has been largely contributory to the reduction in the price of high-class automobiles and this seems to affect an appreciably large part of the population. In certain other matters, such as the manufacture of books, it has improved quality even if it has not reduced price, and in this way has made a substantial contribution to the national income.

The ultimate effect of scientific management cannot make itself felt, however, until a considerable number of plants within the same industry have adopted it so that they begin to compete between themselves. So long as but one or two have it, there is no strong reason for their surrendering the differential gains they get by selling at the market price set by their less efficient competitors. That is in general the condition to-day. Further, the improvements due to new methods are not reflected in the price of the article to the consumer until they directly affect consumers' goods. Scientific management thus far has been applied mainly to the production of intermediate producers' goods.

The elasticity of demand may also be expected to have an influence on the reduction of

the cost of living. When the results of scientific management are obtained in the production of a commodity whose demand is inelastic, the increase in output may be expected to lead to a material reduction in cost and the comparatively rapid elimination of the marginal producer. If, on the other hand, the demand is elastic, as in the case of watches, the superior facilities of production may spread themselves over a wider variety of product, resulting in only a slight decrease in price and without materially affecting the marginal producer except after a long period.

It must be observed, however, that the lower cost of production may fail partially of its normal effect on the market price because the cost of distribution may remain unchanged or even increase. Where the cost of marketing as in many commodities is greater than the cost of production, decreases in the latter cost are relatively of less importance. Again it may conceivably happen that the cost of marketing the increased product due to superior productive efficiency may, in accordance with the law of diminishing returns, increase more rapidly than the cost of production has decreased, in which case the net result is an increase in market price. The answer to this, of course, from a

social point of view is not to refrain from reducing the cost of production because the cost of marketing may be increased thereby, but rather to turn the same scientifically trained and analytical attention to the problems of distribution that has been applied to the problem of production. While it is true that many of the mechanisms of the Taylor System as exhibited in factories are not transferable bodily to transportation, jobbing, wholesaling, and retailing, there is none the less a reasonable ground for scientific faith that the same fundamental principles are applicable and must, in the interests of economic efficiency, sooner or later be applied; and in fact a beginning has already been made in that direction.

On the problem of unemployment scientific management has already contributed valuable experience and has pointed out the way in which a partial solution may be found. One of the greatest causes of unemployment, aside from the maladjustments due to crises and panics over which scientific management can have no control, is the seasonal fluctuation in demand found in so many industries. From the point of view of scientific management these seasonal fluctuations mean exceptionally high cost of production during periods of activity,

due to the sudden access of workers who have to be trained quickly and to the multitude of rush orders that interfere with the steadiness of administration under which any system works most effectively. Scientific management has therefore insisted on equalizing the demand. This is done by offering special inducements to customers to place orders that can be executed during the otherwise dull periods. The cost-accounting methods, which propose to equalize the cost of production by charging the loss due to unused plant and equipment directly to profit and loss rather than to the cost of production, do not relieve the management of the necessity of making up this loss by more effective marketing. The results of the policy insisted on by scientific management are steadier employment for all workers and less fluctuation in the earnings of piece workers. This is promoted by the policy of training employees in different kinds of work, so that when the demand slackens in one department they may be easily transferred to other departments in which the demand is greater.

There should also be noted the effect of the higher wages that accompany scientific management. In the first place, it tends to reduce the restless wanderings of employees from plant

to plant, which is one important though comparatively unexplored cause of unemployment. In the second place, steadier employment, by increasing the value of the employee to his plant, tends itself to raise his wages still further. This improvement when properly utilized by the management reacts again on the cost of production, ultimately in some cases on the selling price and the demand for the product, and finally back again on the demand for workers.

As yet scientific management has not in fact seriously affected the problem of unemployment. It is safe to say that it has in no case reduced the number of men actually employed, while, on the other hand, it has in several instances increased that number. Either result, however, has affected such a small number of plants as to have been but an insignificant factor, compared with those larger and vaster economic forces whose effect is registered in the number of the unemployed.

Closely connected with the problem of the unemployed is that of the education and skill of the employee. In periods of decline in business the men first laid off are those who are the most costly, and as a rule these are the relatively uneducated and unskilled. What effect has scientific management on this problem?

Efforts to revive apprenticeship, either in the old form under master-workmen or in the new form of apprentice schools, may by this time be set down as failures. To-day there is practically no such thing as a master-workman who is acquainted with all the traditions of his handicraft. Practically all workmen are specialized and the utmost they can teach is the little specialty they have learned, a specialty which in many instances can be taught in a few days or even in a few hours. The apprentice schools attempt to give a smattering of all-round acquaintance with the job. When they are connected with plants, they reduce this as much as possible, plunge at once into specialized training, teach the youth to do a limited job, and keep him doing a man's work for a boy's pay as long as practicable. When they are not connected with industrial establishments they go to the other extreme and teach a mass of traditional technique and theory, often with the aid of antiquated and obsolete equipment, which is useless and promptly forgotten when the youth is confronted by a real job under commercial conditions.

Scientific management changes all this. Power-driven machinery had already increased output by the substitution of mechanical

power, speed, and endurance, for the corresponding human qualities. Scientific management goes farther and increases output by the mastery of the natural laws involved and by increasing human skill and control. The effect of scientific management, therefore, is to put a premium on personal capacity and development. This it does by its policy of individualized and intensive training, specialization, and the substitution of definite high standards of accomplishment for the old feeling of all-round but indefinite capability.

This policy, of course, gives occasion for complaint about the effects of ever greater specialization. Since the industrial revolution began it has been considered proper to mourn the disappearance of the traditional all-round artisan. But is his passing really a misfortune either for himself or society? In the first place, it is doubtful if there were very many of him. To be versatile is not difficult, but to exhibit great capability in versatility is rare. If we may judge from their modern representatives, most of the all-round artisans were more versatile than capable. In the second place, the all-round artisan was content with a standard of accomplishment which is far lower than that expected of and by his modern specialized suc-

cessor. The workman who to-day does one comparatively minute operation and does it with superlative excellence is, in his own opinion and that of society, a stronger and more capable man. His standards are raised and with it his self-respect and the esteem in which he is held. It may be pointed out further that the increasing development of specialization makes possible the discovery and training of exceptional capacity along special lines which might otherwise be obscured by the variety of duties imposed. Specialization in foremanship opens a new field of promise to many who were heretofore known as ordinary workmen. The tendency of scientific management is to recognize the fact that most men are ordinary, and provide for the most effective coöperative utilization of ordinary capacities. Its chief means for the accomplishment of this purpose is specialization and intensive individual training.

It is hardly necessary to add that this argument does not go so far as to propose the elimination of general and trade education. The social and political justification of such education remains as strong as before. Moreover, the tendency to substitute a knowledge of fact and of law for guesswork and tradition demands a degree of general intelligence and

education which was quite unnecessary under the old methods of production. Scientific management adds a quantitative value to education.

The effect of scientific management on inequality of income has been suggested in former parts of this discussion and will be summarized here. The increase in the supply of managers (at least of the routine type) will, in the first place, reduce the wages of management. At the same time it will increase the demand for capital; and this, together with the greater productivity of the capital employed, will tend to raise the rate of interest. A similar increase in the demand for workmen and in their productivity will raise general wages. The two consequences are compatible because the sum total of the "national dividend" will be larger. At the same time the sharper differentiation of individual abilities and the payment of wages in proportion to efficiency will tend to maintain and even to raise wages still higher.

Certain of these tendencies are permanent, others but temporary. The increase in the supply of managers and the differences in ability of workmen will doubtless remain. The higher rate paid for capital, however, will tend so to increase the amount of it that becomes avail-

able as to result eventually in a return to the previous rate of interest; so that in the long run, if the tendencies of scientific management were allowed to work out freely and without interruption, rent and profits, in the narrow sense, would be unaffected, interest would first rise and then fall again, wages of management would tend to become less, and workmen's wages higher. These are obviously steps toward greater equality of income than now prevails.

A question of concern to many is the probable influence of scientific management on the tendency toward democracy in industry. What is meant by democracy in industry seems to vary with different thinkers and with the same thinker at different times. We will assume that it means at least a share in the control of industry and free opportunity for advancement.

An industry which is governed by facts rather than by traditions and opinions is fundamentally democratic, at least in the sense that it is immaterial whether the fact is produced by the general manager or the humblest lumper. Arbitrariness on either side is eliminated. Any workman may appeal to the arbitrament of facts with the same certainty of justification as the highest official. In this sense control becomes impersonal; which is a step in advance

from the current type of arbitrary personal control.

On the other hand, with the increasing specialization of modern management a greater degree of centralized control is necessary than before and this control must ultimately be exercised by one human being over another. To those who consider any degree of restriction of individual liberty, even in the interests of a coördinate activity, a derogation of democracy, scientific management must be undemocratic; in fact any management must be. So is any type of government. The only alternative is anarchy. If this extreme view is not held, the question becomes whether the control whose necessity is admitted shall be exercised by persons chosen by the controlled or by some other agency. Experience with coöperative productive enterprises has shown the present impracticability of the selection of industrial leaders by the rank and file of the employees. On the other hand, a long history of favoritism, nepotism, indifference, and ignorance has shown the inadvisability of arbitrary selection by owners and managers. Scientific management provides a method of selection by capacity. In other words, its type of government is that of an aristocracy of demonstrated ability,

tempered by the necessity of retaining the good-will of the employees without which the methods of scientific management cannot be successfully operated, and further ameliorated by the type of discipline which wells up from beneath and is at least partially self-enforcing.

That such is in fact its result is evident to any one investigating a plant in which scientific management has secured a firm foothold. The executives are but slightly removed from the ranks of the workmen and are in fact as well as in theory the servants of the men. The men occupy a new position of power and responsibility of which they are fully cognizant and have even been observed reminding their "bosses" of any failure in the adequate performance of the bosses' duties.

The characteristic regard for impersonal fact, the greater mobility between ranks, and the keener appreciation of individual abilities, characteristic of scientific management, provide opportunities for advancement far greater than those commonly observed. There are large differences in the capacity of manual workers. These differences are made evident by time study, are immediately recognized, and the capable workman is an object of exceptional esteem. A long-run effect of this is to transfer

esteem from the workman to the work as such and to increase the self-respect of workmen and their regard for their personal rights and corresponding obligations. All these would seem to be in the direction of a sane democracy.

IV. Forecast of the Future

Unless scientific management has before it a long and influential future all the foregoing discussion has a merely academic interest. It has established a firm foothold in the short period of its existence. Whether it will live and grow depends upon whether its inherent advantages can offset some of the difficulties now in the way of its development.

Chief among these obstacles is the conservatism and mental inertia of business managers. Business is proverbially cautious, one might almost say unprogressive. Managers consider that even in the beaten paths the risks are great enough; and it is only the exceptionally bold or the rash who will step out into the unknown, even though it may look promising. As success after success is scored by the pioneers, ordinary managers get over their timidity. To-day there is evidence of an almost undue haste to adopt the new methods. The demand for scientific management has brought forth a horde of

"efficiency experts," untrained, incompetent, sometimes quacks and charlatans, whose operations are tending to discredit the name and purpose of the movement. This phase shows signs of passing, and we seem to be settling into a period where the progressive but skeptical manager is coming to the front, who must first be convinced, and when convinced commits himself to the patient development of real science in his plant.

Another obstacle is the cost of the best-known systems, owing to the scarcity of experts capable of developing them and the necessity of finding out, by expensive experiment, the very A, B, C, of the science of each new industry to which the methods are applied. The cost of the first few steps which are now being taken is so high that only plants able and willing to make an investment of $30,000 or $40,000, without the expectation of large returns for two years or more, are in position to undertake the development. This obstacle also tends to disappear as experience demonstrates the certainty and largeness of the returns from such investment.

The scarcity of engineers capable of developing scientific management also retards its extension. At present it is safe to say that there are not over twenty in the entire country. As

all of them give their time personally to the development of their work, this puts a serious limitation on the number of plants that may avail themselves of their services. The only remedy is the discovery and development of younger men in the same field. There are signs that since Mr. Taylor's death the liberal policy of the originator of scientific management is being restricted somewhat by his immediate followers. The attention given to the subject in the colleges and business schools of the country, and the increasing demand for specialists in this work, will aid in overcoming the difficulty.

To a certain extent the distrust of social workers and the opposition of organized labor tend to retard the movement; but it is my impression that the publicity resulting from active opposition, when followed by investigation and publication of facts, as it usually is, tends to aid it. There can be no question that the recent congressional debates on scientific management in the Watertown Arsenal case, uninformed as on the whole they were, called the attention of business men to the actual facts regarding the Taylor System, and resulted in an increasing interest and a desire to secure its advantages.

This enumeration of the obstacles to the development of scientific management betrays

their smallness and transitoriness in comparison with the greatness and permanence of the forces with which its progress is allied. Already it is demonstrating its capability of great industrial and social advantage to its users. Its close relationship to the movement for the conservation of all resources has been pointed out and its far-reaching consequences as an agency for the conservation of human effort have struck forcibly the popular imagination. Finally, its inherent democracy, as exhibited in its substitution of fact, so far as possible, for the vagaries of personality, and its provision of self-government and unlimited opportunity for advancement, tie it closely to the most intelligent political movements of the day. While it would be idle to deny that there are countertendencies to all these and that there have been abuses and misinterpretations of the principles of scientific management,[1] it seems safe to believe that on the whole it represents an inevitable and irresistible tendency, and that therefore its extension and permanence are assured, so far as, historically speaking, there may be assurance of permanence.

[1] The discussion of positive management in the recent book of Hoxie, Valentine, and Frey, *Scientific Management and Labor*, seems to rest on a consideration chiefly of abuses and inadequacies of the movement.

V

THE LITERATURE OF SCIENTIFIC MANAGEMENT

THE literature of scientific management is found in a few books written by practitioners of the science, a few official reports growing out of disputes as to railroad rates and labor difficulties, technical articles which have appeared in the *Transactions* of engineering societies and in engineering and other technical magazines, and a considerable mass of "popular" articles written to satisfy the recent widespread popular interest in the subject.

These books and articles may be classified, for the purposes of the present review, in six groups.

The first group includes those incidental to or dealing with the development and theory of scientific management as a whole. It consists of the original publications of the pioneers and such popular statements as reveal a clear grasp of the movement.[1]

The second group includes descriptions of

[1] Many of the popular articles are evident pot-boilers, too ill-considered and ephemeral to be worthy of discussion and preservation.

scientific management in operation, written as a rule by managers of plants which have developed the system.

As a result of the injection of scientific management into the discussion of railroad rates, there has arisen a considerable body of literature on the possibility of the application of the system to railroads. This is of sufficient consequence to constitute the third class.

In the fourth class are the many detailed descriptions of methods which are either distinctive of scientific management, or, though not peculiar to scientific management, coördinated and assimilated by it into its own system.

Those methods of scientific management which affect most directly the human factor in production have stimulated a literature which is of sufficient importance to warrant being put into a fifth class by itself.

In the sixth and last group is the series of discussions dealing with the relation of scientific management to organized labor.

To this classification of special books and articles should be added a word regarding the magazines which have dealt more or less fully with the subject. One of the chief among these is the *Engineering Magazine*, which was largely

instrumental in bringing to the attention of the engineering profession the early work of Mr. Taylor and especially the ideas of Mr. Harrington Emerson. *Industrial Engineering*, which was unfortunately quite short-lived, devoted itself particularly to the work of the Taylor group. *Factory* and *System*, especially the former, have published many articles on the subject of scientific management and their editorial tone has been considerably influenced by that movement. An excellent little magazine called *One Hundred Per Cent* (after its original name, *Efficiency*, had been dropped) is devoted almost exclusively to the methods and practice of scientific management engineers. The following pages will contain many references to articles in these magazines.

The more important books and articles are discussed briefly in the text. Others not sufficiently distinctive or noteworthy to call for special review, but important for students of the movement, are referred to in the notes. The text and notes together cover nearly ninety per cent of all that has been published on the subject.[1]

[1] Bibliographies covering scientific management may be found in the *Efficiency Number*, *Special Libraries*, vol. 4, no. 5, pp. 69–109, published by The Special Libraries Association, Indianapolis, May, 1913, and in a selected list issued by

1. Development and Theory of Scientific Management as a Whole

In 1832, Charles Babbage, the eminent mathematician, published a book[1] in which he attempted to deduce from the practice of manufacturing as it existed in his time, the general underlying principles which apparently controlled it. This piece of work, though crude in the light of modern advance, was so far ahead of the state of contemporary manufacturing intelligence that its significance was entirely overlooked, and it is only to-day that the force of his analysis is evident. Although it does not appear that the modern group of scientific managers are in the slightest degree indebted to Babbage's work, it is interesting to observe in it the suggestion of the extension of specialization beyond manual labor to mental labor, which is at the basis of the Taylor doctrines of functional foremanship and the separation of planning from execution. Babbage also fore-

myself under the title *Bibliography of Scientific Management*, published by the American Library Association, Chicago, in 1916. Many references to books and articles may be found in the *Engineering Index*, published by the Engineering Magazine Company, and in the *Bibliography of Labor*, published annually by the Massachusetts Bureau of Statistics.

[1] *The Economy of Manufactures*. London, 1832. (Out of print.)

shadows the use of timing as an aid in the development of processes; but in this he was not so fortunate, and the undeveloped method he used is not even remotely connected with modern time study.

The important stimulus to the modern development is found in the work of a group of managers and engineers, members of the American Society of Mechanical Engineers, who drew the attention of their fellow-members to the influence of wages on the output of workmen. The earliest of these was Mr. Henry R. Towne, president of the Yale & Towne Manufacturing Company. Mr. Towne has always been essentially a thinker in industry. Early in the eighties he wrote a paper [1] which was a plea for the technically trained engineer to concern himself in the financial and profit-making aspects of management — to be an "economist" because he effects economies. As a result of taking his own advice in his own plant, and after a realization of the practical inefficiency of profit-sharing as an incentive to production, Mr. Towne evolved [2] and described a modified type of profit-sharing which he called "gain-shar-

[1] "The Engineer as Economist," *Transactions*, American Society of Mechanical Engineers, vol. 7, p. 425. (These *Transactions* will be abbreviated hereafter *Trans.*, A.S.M.E.)

[2] "Gain-Sharing," *Trans.*, A.S.M.E., vol. 10, p. 600.

ing." It consisted in modifying profit-sharing by applying it to departments instead of to the business as a whole, and basing it upon demonstrable gains in the efficiency of departments as evidenced by careful accounting. Out of the discussion of this paper grew practically the entire modern literature on wage systems as incentives.

Prominent on this subject were the papers of Mr. F. A. Halsey and Mr. James Rowan [1] and an article by Mr. Rowan.[2] The object in the mind of these managers was to provide a definite basis on which gains in efficiency could be measured, and to bring the gain and the consequent bonus home to the individual workman. It was an attempt to remedy the defects both of profit sharing with its indefiniteness and of piece rates with their temptation to cutting; and it amounts practically to the rough determination of a standard of individual performance and the announcement in advance of a systematically graded and expected cut.

[1] "The Premium Plan of Paying for Labor," *Trans.*, A.S.M.E., vol. 12, p. 755. Reprinted in *Sibley Journal of Engineering*, vol. 16, p. 219, and in *Trade Unionism and Labor Problems*, chap. xi, edited by John R. Commons. (Boston, 1905.)

[2] "A Premium System Applied to Engineering Workshops." *Proceedings*, Institute of Mechanical Engineers, March 20, 1903, p. 203.

While this discussion (the very considerable literature of which is outside the scope of this paper)[1] was in progress, Mr. Frederick W. Taylor, at that time foreman and master-mechanic of the Midvale Steel Company, was trying to solve the problem of individual and plant efficiency by another and an essentially different method. One result of his experiments was the development of a new form of piece rate now known as the "differential piece rate," according to which a workman is paid a low rate per piece for ordinary production and a considerably higher rate for production according to a standard, determined by careful and accurate time study, and made possible of attainment by systematic training of the workman and by such management of the plant as facilitates to the utmost the operations performed by the laborer. Mr. Taylor's first statement of his methods and results was submitted to the American Society of Mechanical Engineers in a paper[2] which has been described by Mr. Going, the accomplished

[1] An excellent review of the discussions on this subject is contained in H. B. Drury's *Scientific Management*, Columbia University Press, 1915. This discussion of the literature is the best part of Drury's book, as his review of the later history of the movement suffers from a lack of practical acquaintance with the methods whose history he attempts to narrate.

[2] "A Piece-Rate System," *Trans.*, A.S.M.E., vol. 16, p. 856.

editor of the *Engineering Magazine*, as "one of the most valuable contributions that have ever been made to technical literature."

At this stage of the development, the system consisted of "three principal elements: (1) an elementary rate-fixing department; (2) differential rate system of piece work; (3) what he (Mr. Taylor) believes to be the best method of managing men who work by the day." The rate-fixing department analyzes and standardizes work and piece rates with the aid of elementary time study. This procedure differs from that of other rate-fixing departments "in that a careful study is made of the time required to do each of the many elementary operations into which the manufacturing of an establishment may be analyzed or divided. These elementary operations are then classified, recorded, and indexed and when a piece-work price is wanted for work, the job is first divided into its elementary operations, the time required to do each elementary operation is found from the records, and the total time for the job is summed up from these data."

The differential rate system of piece work is defined briefly as "offering two different rates for the same job, a higher price per piece in case the work is finished in the shortest possible

time and in perfect condition, and a low price if it takes a longer time to do the job, or if there are any imperfections in the work (the high rate should be such that the workman can earn more per day than is usually paid in similar establishments)." The best method of managing men who work by the day "consists of paying *men* and not *positions*. Each man's wages as far as possible are fixed according to the skill and energy with which he performs his work, and not according to the position which he fills. Every endeavor is made to stimulate each man's personal ambition." The advantages of this system, as deduced by Mr. Taylor from ten years' experience with the Midvale Steel Company, are: first, lower cost of production with, at the same time, higher wages; second, by substituting knowledge for guesswork, the elimination of the motive for "soldiering"; third, the substitution of exact knowledge leads to a treatment of the men with greater uniformity and justice, and their response with more and better work; fourth, coöperation of the men and the management is made obviously their common interest; fifth, the system is rapid in attaining the maximum productivity, which is automatically maintained by the differential rate; sixth, it selects and attracts the best men,

develops many slow and inaccurate workmen into first-class men, and discourages and sifts out men who are incurably lazy or inferior; seventh, "it promotes a most friendly feeling between the men and their employers, and so renders labor unions and strikes unnecessary."

The paper then proceeds to discuss the Towne and Halsey wage systems and profit-sharing, and points out the absence in all of them of a definite measure of a day's work. It then describes the method of elementary rate-fixing and the application of the differential piece rate by its means, with illustrations of the results attained.

It is significant of Mr. Taylor's habit of mind that this early paper is a description of methods and results, including hardly a suspicion of theoretical deduction. It is a testimony to the accuracy of Mr. Taylor's later statement that scientific management is not a theory to be applied to practice, but that it is first and primarily a practice out of which, many years after its beginning, a theory has developed.[1]

[1] An interesting description of the application of this form of piece rate is found in "The Taylor Differential Piece-Rate System," *Engineering Magazine*, vol. 20, p. 617, by Mr. Sanford E. Thompson, one of the early collaborators with Mr. Taylor and a recognized expert on time study. A good discussion of the whole matter grew out of a weak paper by Mr.

The difficulty of bringing a plant to the necessary perfected degree of administration and the apparent severity of the differential piece rate led one of Mr. Taylor's collaborators, Mr. H. L. Gantt, to develop a different form of premium system, which retained, however, the essential element of an accurate time-study basis. This method, known as the "Gantt bonus plan," is a time-rate method. It guarantees the operator the regular hourly or daily rate, but adds a bonus for achievement of the standard quantity and quality of work, known as "the task." This standard is set, as with Mr. Taylor's differential piece rate, by time study. Mr. Gantt has published a large number of articles on the subject, the best of which, together with his own development of the relation of scientific management to some of the human problems involved, have been collected in one volume.[1]

Mr. Gantt points out how by the ordinary methods of management the cost of production, which is at the basis of the great problem of the increasing cost of living, follows a vicious circle

F. Richards, "Is Anything the Matter with Piece Work?" *Trans.*, A.S.M.E., vol. 25, p. 68, participated in by Mr. Taylor, Mr. Emerson, and others.

[1] *Work, Wages and Profits.* (New York, 1910.) The first edition, published in 1910, is somewhat enlarged and considerably revised in the second edition, 1913.

of higher wages to meet higher cost and increased cost as the result of higher wages. The way out is to manage production in such a way that higher wages bring a decreased cost; and this is the aim of scientific management. This is accomplished by standardizing the conditions for efficient operation, instructing the workmen thoroughly in the best methods, and using wages as an inducement to them to accept the instruction and the conditions provided. The development of the Gantt bonus and its relation to piece work are described in detail, and the effect of the system on the workman's habits of industry and coöperation is outlined and demonstrated with charts and diagrams showing comparisons between old methods and the new. These charts, based upon the records of actual workers, are extraordinarily interesting human documents, showing the gradual overcoming of difficulties and the fixation of habits of punctuality, reliability, and efficiency. The 1913 edition adds a chapter to the effect that, as the great natural resources of this country can be relied on less and less in competition with other countries, our future depends upon the application of scientific methods and the increase in the efficiency of operation, and concludes with a brief chapter

illustrating some of the detailed methods of the Taylor System as developed by Mr. Gantt.

This book of Mr. Gantt's is one of the best that has appeared on the subject and is entitled to rank with Mr. Taylor's *Shop Management* and *The Principles of Scientific Management*, as one of the standard authorities.

Scientific management, however, is not merely a system of wage payment. One of its essential features is the determination and application of standards not only of performance, but of methods and equipment. In fact, it is a cardinal principle of scientific management that a proper standard of performance cannot be attained in the absence of standardized methods and equipment; and it was in the effort to secure standard performance that Mr. Taylor and his associates were led to investigations of detailed processes which have themselves become classics. One of the earliest of these is Mr. Taylor's "Notes on Belting," [1] which, with the later paper by Mr. Carl G. Barth,[2] has had an immense influence on the current manufacture and use of belts. Another investigation growing out of Mr. Taylor's work was concerned with the proper com-

[1] *Trans.*, A.S.M.E., vol. 15, p. 204.

[2] "Transmission of Power by Leather Belting," *Trans.*, A.S.M.E., vol. 31, p. 39.

position and method of heat treatment of tool steel, and the shape of cutting tools. This investigation, carried on with the assistance of Messrs. Gantt, Barth, and Maunsel White, and extending over twenty-six years, led incidentally to the discovery of high-speed steel, which has revolutionized machine-shop practice and the design and construction of machine tools all over the world. The results of this investigation are published in a paper called "The Art of Cutting Metals." [1]

While Mr. Taylor was carrying forward in a variety of industries the development of his distinctive type of management, but was publishing nothing about its details,[2] Captain

[1] *Trans.*, A.S.M.E., vol. 28, p. 31. An interesting explanation of one of the means by which Mr. Taylor's results are applied in machine-shop practice is found in the paper by Mr. Carl G. Barth, the mathematician of the group, on "Slide Rules as Part of the Taylor System," *Trans.*, A.S.M.E., vol. 25, p. 49. An illustration of the effect of such work as a stimulus to the application of thought to management appears in the article by Mr. Charles Day called "The Machine-Shop Problem," *ibid.*, vol. 24, p. 1302, which emphasizes the need of coördination, analysis, and a scientific determination of facts.

"The Art of Cutting Metals" is reviewed by A. Wallichs and O. Petersen, *Taylors untersuchungen über rationelle Dreharbeit.* (Stahl und Eisen, 1907, Nos. 29 and 30, Düsseldorf.)

[2] The only paper by a member of the Taylor group dealing with any detail was Mr. Gantt's "Graphical Daily Balance in Manufactures," *Trans.*, A.S.M.E., vol. 24, p. 1322, which was a description of the method of scheduling introduced by him at the American Locomotive Works.

Henry Metcalf had been developing independently and describing [1] a system of routing and accounting in the government arsenals, and Mr. Oberlin Smith, president of the Ferracute Machine Company, had presented an interesting paper on the naming of machine parts.[2] When the opportunity came Mr. Taylor helped himself freely to the suggestions in these papers and incorporated them, with considerable modification, into his practice.

Finally, after twenty years' experience, Mr. Taylor submitted to the American Society of Mechanical Engineers the history and methods of his system in what seemed to him to be definite, complete, and coördinated form. This was his famous paper on "Shop Management," [3] which has been extensively reprinted and translated into French, German, Dutch, Italian, Russian, Lettish, and Japanese. In response to the popular interest in the subject brought about by the railroad rate case in 1911, Mr. Taylor was induced to publish a less technical

[1] "The Shop Order System of Accounts," *Trans.*, A.S.M.E., vol. 7, p. 440. *The Cost of Manufactures and the Administration of Workshops.* (John Wiley & Sons. New York, 1885. 3d edition, 1907.)

[2] "The Naming of Machine Parts," *Trans.*, A.S.M.E., vol. 2, p. 366.

[3] *Trans.*, A.S.M.E., vol. 24, p. 1337. (New edition. New York, 1911.)

statement under the name *The Principles of Scientific Management.*[1]

"Shop Management" is a considerable expansion of the earlier paper on "A Piece-Rate System," and includes much of the detailed methods that had been developed by Mr. Taylor in the intervening years, together with some analysis of the industrial and economic principles involved in his system. The emphasis is laid throughout on the importance of "the coupling of high wages for the workman with low labor cost for the employer," and the eventual interest of the public in the reduced prices resulting from this combination. The difference between the "first-class man" and the average workman, the means for selecting or developing the former class, the methods of accurate scientific time study, the philosophy and operation of the task idea in management, the determination of standards, the separation of planning and execution, the development of functional foremanship and the planning department, and steps to be taken in changing from ordinary to "the best type of management," are dealt with extensively. Emphasis is laid on the "evils of

[1] Harper & Bros., New York, 1911. A very brief résumé by Mr. Taylor, "Principles and Methods of Scientific Management," is found in the *Journal of Accountancy*, vol. 12, pp. 117, 181.

soldiering" and the failure of piece rates and premium plans to overcome them; it appears that Mr. Taylor's entire system grew out of his determination to break up this practice.

The objects sought can be attained, according to Mr. Taylor, most easily by the application of the following principles: —

(*a*) *A Large Daily Task.* Each man in the establishment, high or low, should daily have a clearly defined task laid out before him. This task should not in the least degree be vague or indefinite, but should be circumscribed carefully and completely, and should not be easy to accomplish.

(*b*) *Standard Conditions.* Each man's task should call for a full day's work, and at the same time the workman should be given such standardized conditions and appliances as will enable him to accomplish his task with certainty.

(*c*) *High Pay for Success.* He should be sure of large pay when he accomplishes his task.

(*d*) *Loss in Case of Failure.* When he fails he should be sure that sooner or later he will be the loser by it.

When an establishment has reached an advanced state of organization, in many cases a fifth element should be added, namely: the task should be made so difficult that it can only be accomplished by a first-class man.

The rest of the book is an amplification of the methods by which these so-called "principles" are applied.

The Principles of Scientific Management[1] develops the same ideas in a slightly different way. Much emphasis is laid on the importance of the substitution of scientific knowledge and incentive on the part of the management for the former reliance on the crudely stimulated initiative of the workman. There is the same discussion of "soldiering," inadequacy of piece and premium systems, and a non-technical review of certain typical methods of the system, with illustrations of the application of scientific method to such diverse operations as shoveling, pig-iron handling, and the cutting of metals.

It is interesting to note in the later book a restatement of the "principles," otherwise referred to as "elements": —

> *First.* The development of a true science. *Second.* The scientific selection of the workman. *Third.* His scientific education and development. *Fourth.* Intimate friendly coöperation between the management and the men.

In an earlier section of the same book, these "principles" are restated in slightly different form as the "new duties" devolving on the

[1] See the articles in the *American Magazine*, vol. 71, pp. 570 and 785, and vol. 72, p. 101, and in *World's Work* (London), vol. 18, pp. 91 and 168.

management. In this case they are given as follows: —

> *First*. They develop a science for each element of a man's work, which replaces the old rule-of-thumb method.
>
> *Second*. They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.
>
> *Third*. They heartily coöperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.
>
> *Fourth*. There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men.

It is evident from these statements that Mr. Taylor does not distinguish sharply between principles, duties, and methods, and it is difficult to see why the methods selected for elevation into the class of principles are limited to those given and do not include such fundamental and radical departures as functional foremanship and the task and bonus. This is but another evidence of the fact that the Taylor System is in reality the summation of years of the varied experience of many individuals,

which has not even yet been thoroughly coördinated and developed into such a system of real principles or laws as characterizes other modern sciences. I believe that the principles are there and that they only await definite and systematic formulation.[1]

In the summer of 1911, the unionized machinists and molders employed at the Watertown Arsenal, where the Taylor System was being developed, walked out; and on being taken back petitioned that the Labor Committee of Congress investigate the subject and recommend such legislation as would be necessary to protect their interests. A committee was appointed consisting of Mr. William B. Wilson, the present Secretary of Labor, Mr. William C. Redfield, now Secretary of Commerce, and Mr. John Q. Tilson, "to investigate the Taylor and other systems of management" in government shops. The investigators confined themselves practically to the Taylor System

[1] Among the foreign reviews of Taylor's books may be mentioned especially the following: G. Deherme, "L'Organisation scientifique du Travail," *La Coöpération des Idées*, 3me Sér., N° 18, 16 Sept., 1912, Paris. R. Lucion, "Le Taylorisme," *Revue Economique Internationale*, vol. 3, no. 2, August, 1912, pp. 389–403. Francesco Giannini, *L'Organizazzione Scientifica del Lavoro.* (Roma, 1912.) Giovanni Aichino, *Organizazzione Scientifica delle Oficine.* (Torino, 1912.) A. Wallichs, *Taylors Werkstattenorganisation.* (Düsseldorf, n. d.)

tem, held hearings at the principal navy yards, and took testimony of workmen, foremen, managers, "efficiency experts," and practically the entire group of Taylor System engineers. The result of their investigation was a brief report that no legislation was necessary. More useful, however, was the publication of the great mass of testimony taken.[1] This report of the hearings is a perfect mine of information in regard to the history, methods, practice, and results of the Taylor System and must be strongly recommended as one of the fundamental sources on the subject.

Another important body of testimony is that introduced by Mr. Louis D. Brandeis as part of the case of the shippers in the "Eastern Rate Case" [2] which is carefully sifted, analyzed, and coördinated in Mr. Brandeis's brief.[3]

The most important publication by Mr. Taylor, in addition to those mentioned, is a book

[1] Hearings before the Special Committee of the House of Representatives to investigate the Taylor and other systems of shop management. (Washington, 1912.)

[2] *Interstate Commerce Commission Reports*, vol. 20, p. 243.

[3] A part of this brief was published under the title *Scientific Management and Railroads*. (New York, 1912.) The testimony in this case had no effect on the decision of the Interstate Commerce Commission; but the spectacular and seemingly extravagant form in which some of the testimony was given by persons outside the Taylor group, but influenced by it, caught the popular fancy and was responsible for the great publicity the movement suddenly attained.

prepared by him and Mr. Sanford E. Thompson,[1] which includes, in addition to an acute analysis of concrete construction, certain chapters on time study and valuable tables of unit times determined in accordance with the Taylor methods.[2]

An interesting series of articles illustrating the breadth of Mr. Taylor's interests is that in the "Cultivation of Golf Greens," [3] detailing the methods and results of experiments with which he occupied his leisure time on his estate near Philadelphia.

Although the Taylor System has been applied to many types of industry other than machine-shop production in which it originated, little has been published on these applications

[1] *Concrete Costs.* (John Wiley and Sons. New York, 1912.)

[2] Two interesting articles by Mr. Taylor, "Why Manufacturers Dislike College Graduates," *Sibley Journal of Engineering*, vol. 24, p. 195, and "A Comparison of University and Industrial Methods," *Stevens Indicator*, vol. 24, p. 37, set forth his convictions in regard to the place of college graduates in manufacturing and particularly his criticisms of their point of view and the handicaps under which they labor and for which their college training is responsible. Chief among these are the inability to concentrate on an undertaking and bring it through to a conclusion, the failure to recognize the importance of punctuality and the value of time and discipline, and a lack of appreciation of the point of view of the workingman.

There is an interesting comment on this in Mr. D. C. Jackson's "Criticism of the Engineering Schools," *Stevens Indicator*, vol. 27, p. 25.

[3] *Country Life in America*, February–June, 1915.

by those closest to the movement. Among the detailed discussions of other industries, however, must be mentioned the book by Mr. Charles Day,[1] dealing with the construction and lay-out of factories. Mr. Day points out the influence of the design of the plant upon the efficiency of operation and details the work incident to its planning and building, from the selection of the site to the construction of buildings and the installation of equipment. Excellent illustrations are given of the best lay-out and routing of materials in factories of different types. Mr. Gantt has published a short paper dealing with the textile industry,[2] and Mr. Day has pointed out the possibility of application to diverse industries, including public service corporations.[3]

The printing industry,[4] mining,[5] agricul-

[1] *Industrial Plants.* (New York, 1911.)

[2] "The Mechanical Engineer and the Textile Industry," *Trans.*, A.S.M.E., vol. 32, p. 499. See also Anon., "The Efficiency Engineer," *American Wool and Cotton Reporter*, February 11, 1915, vol. XXIX, p. 156.

[3] "Management Principles and the Consulting Engineer," *Engineering Magazine*, vol. 41, p. 133.

[4] Anon., "Scientific Management — Can it be applied to the Printing Industry?" An editorial, *The Printing Art*, vol. 17, pp. 223–26. May, 1911.

[5] G. A. Collins, "Efficiency-Engineering Applied to Mining," *Bulletin*, American Institute of Mining Engineers, no. 69, 1912. P. B. McDonald, "Efficiency Engineering in Lake Mines," *Engineering and Mining Journal*, October 28, 1911, vol. 92, pp. 845–46.

ture,[1] and timber preserving,[2] have also had attention. Particularly suggestive articles on the application of scientific management to public business have been written by the well-known engineers, M. L. Cooke, of Philadelphia,[3] and Guy C. Emerson, of Boston.[4]

Growing out of the contributions of Mr. Taylor and his original group are a number of articles dealing with the theory of scientific management as it appears to those who first met it in its developed form. Among the most interesting of these are the Report of the Sub-Committee on Administration of the American Society of Mechanical Engineers.[5] This report, after pointing out the reasons for the present great popular interest in the subject, attempts to find the one basic principle in the movement, and discovers it in "the transference of skill." Just as the introduction of machinery meant "the transference of skill from the inventor or

[1] W. J. Spillmann, "The Efficiency Movement in its Relation to Agriculture," *Annals*, American Academy of Political and Social Science, vol. 59, p. 64.

[2] E. A. Sterling and D. Burkhalter, "Efficiency and Scientific Management in Timber Preserving Plants," *Railway and Engineering Review*, March 16, 1912, vol. 52, pp. 237–39, 244.

[3] "Scientific Management of the Public Business," *American Political and Scientific Review*, vol. IX, no. 3.

[4] "Scientific Management in the Public Works of Cities," *National Municipal Review*, October, 1913, vol. 2, pp. 571–82.

[5] "The Present State of the Art of Industrial Management," *Journal*, A.S.M.E., May, 1913, p. 871.

designer to the power-driven mechanism," so scientific management is the transference of skill from the manual worker to the planning department and functional foremen, resulting in the saving of labor and the increased output and reduction of cost. The report includes a collection of interesting attempts to state the underlying principles of scientific management.

Mr. Forrest E. Cardullo [1] has compared "conventional," "systematic," and "scientific" management, with illustrations of administration of the various types. Then follows a discussion of the causes of current inefficiency, which may be grouped into three classes: those which are chargeable primarily to the employer, those which are chargeable primarily to the workman, and those which are chargeable primarily to our political and industrial system. They include mental laziness, prejudice against so-called "non-productive" labor, timidity of capital, lack of foresight and adaptability, mental inertia, lack of study of industry, inefficient wage systems, and avarice, on the part of the management; and on the part of the workmen, disinclination to work at other than their accustomed pace, lack of ambition, mental

[1] "Industrial Administration and Scientific Management," *Machinery*, vol. 18, pp. 843, 931; vol. 19, p. 18.

laziness, and enmity to their employers; and on the part of the political and industrial system, periodical depressions, seasonal variations in work, intense individualism, wasteful competition, and sudden changes in laws, customs, fashions, and social conditions. The paper closes with an enumeration of the objections to scientific management and the answers to them and is, on the whole, one of the best contributions to the subject.

Lieutenant G. J. Meyers [1] has made an interesting attempt to deduce and formulate "laws" of management. He gives the following synopsis of laws: —

Law I. What to do.
Law II. Instructions before work starts.
Law III. Machines and tools.
Law IV. Workmen.
Law V. Insure instructions are carried out.
Law VI. Costs.
Law VII. Study for improvements.

Each statement begins: "It is necessary in any activity." Thus Law I is in this form: "It is necessary in any activity to have a complete knowledge of what is to be done and to prepare instructions as to what is to be done before the work is started"; and so for each topic in the

[1] "The Science of Management," *Journal*, American Society of Naval Engineers, vol. 23, p. 994.

synopsis. The formulation of each law is followed by a brief statement of the reasons for it and the method of its application. The paper is a highly interesting essay in the formulation of industrial principles.[1]

The present writer [2] has pointed out that the time study methods of the Taylor System provide a definite basis for one side of the wage bargain: to wit, the content of a day's work, but

[1] To these should be added the following: Mr. H. P. Kendall's "Management: Unsystematized, Systematized and Scientific," *Scientific Management*, Tuck School Conference, 1912, p. 112; reprinted in *Industrial Engineering*, vol. 10, p. 374; also in *Proceedings*, 27th Annual Convention of the United Typothetæ and Franklin Clubs of America, pp. 140–65 (Chicago, 1913. 250 pp.), and in *Journal of Political Economy*, July, 1913, vol. 21, pp. 593–617, — a comparison of the types of management mentioned, based on the writer's personal experience with the last two and a wide acquaintance with the first. Mr. Tracy Lyon's brief review of principles in "Scientific Industrial Operation," in *Technology and Industrial Efficiency*, p. 200. (New York, 1911.) Reprinted in *Iron Age*, vol. 87, p. 922, and in *Industrial World*, vol. 45, p. 464. Mr. A. Hamilton Church's "The Meaning of Scientific Management," *Engineering Magazine*, vol. 41, p. 97, which is one of numerous suggestive but unsuccessful attempts to find "the one" principle underlying the movement. Finally, the editorial, "Scientific Management More Than a Labor Problem," *Industrial Engineering*, vol. 11, p. 467, pointing out the inclusiveness of the method. See also Coburn "The Science and the Art of Management," *Iron Age*, January 23, 1913, vol. 91, pp. 248–49; and John H. Van Deventer, "The Ultimate Type of Management," *Engineering Magazine*, June, 1915, vol. XLIX, no. 3, p. 394.

[2] C. B. Thompson, "Relation of Scientific Management to the Wage Problem," *Journal of Political Economy*, vol. 21, p. 630.

makes no attempt to determine the equivalent day's wage, except to provide a means through the bonus or differential rate for the application of the principle that superior service should be paid at a superior rate.

M. LeChatelier's Introduction to the French translation of *The Principles of Scientific Management* discusses the fear both on the part of the employers and the workmen, that the radically new methods of scientific management will bring about critical economic problems of readjustment; and lays this fear to ignorance of the gradual working-out of economic changes. Professor Veblen has included scientific management in his broad survey of the influence of types of industrial organization and "culture" on technological proficiency.[1]

Mr. Morris L. Cooke, formerly director of Public Works in the City of Philadelphia, and one of the later additions to the original Taylor group, was retained by the Carnegie Foundation to make an investigation of academic efficiency from the point of view of an industrial administrator.[2] Mr. Cooke discusses current types of university organization, the college

[1] *The Instinct of Workmanship and the State of the Industrial Arts.* (New York, The Macmillan Company, 1914.)

[2] "Academic and Industrial Efficiency," *Bulletin*, Carnegie Foundation, no. 5, 1910.

teacher as a producer, research, the economical use of buildings, functional activities, financial administration, and student administration. According to him, there is no present gauge to efficiency in academic work and, while recognizing that the product of the university is of so intangible a nature as not to be subject to exact measurement, he points out the possibility of the application of a unit, the student-hour, to the measurement of administrative efficiency. His discussion is brought to bear in detail upon the administration of a physics department and includes an application of some of the methods of industrial administration.[1] An interesting

[1] The following articles may be taken as samples of the comment provoked by this study: "Educational and Industrial Efficiency," *Science* (N. S.), vol. 33, p. 101, by Richard C. Maclaurin, President of the Massachusetts Institute of Technology, who is apprehensive that the methods proposed by Mr. Cooke will consume too much of the time of officers of instruction and will tend to distract attention from the fundamental purpose of a university; "Educational or Administrative Efficiency," *Engineering Magazine*, vol. 40, p. 606 (anonymous); and "Scientific Management and Academic Efficiency," *Nation*, vol. 93, p. 416, by Professor A. G. Webster. Mr. Cooke's proposals are appreciatively reviewed by Professor H. F. Person in "Academic and Industrial Efficiency," *Dartmouth Alumni Magazine*, vol. IV, p. 126 (1912); and "Academic Efficiency," *Bulletin*, Society for the Promotion of Engineering Education, vol. IV, no. 2, p. 39 (1913). See also *Industrial Engineering*, vol. 9, pp. 216–17 (March, 1911), a reply to Maclaurin. There is a series of papers by "practical men," not particularly well informed and highly theoretical, on "Scientific Management and Efficiency in College Administration." (Ithaca, New York, 1913.) Henry LeChatelier,

attempt to establish standards in elementary education, with suggestions of reforms based on business standards is made by J. M. Rice.[1]

Interesting suggestions for the partial or complete application of the Taylor System to varied industries are made by Mr. F. B. Gilbreth [2] when he shows the revolutionary result of the application of motion study to a trade so ancient as laying bricks, and by Mr. B. M. Ferguson [3] who details the favorable results of his experiments, particularly in its application to outdoor construction.

The success of the application of the Taylor System to the government arsenals drew the attention of engineers in the navy to the possibility of its application to their branch of the service. This is discussed by Mr. C. S. Brewer [4]

in "Le Système Taylor, Science expérimentale et psychologie ouvrière," Paris, 1914, *Bulletin*, la Société des Amis de l'École Polytechnique (Paris, 1914), discusses the bearing of scientific management on the modification of technical training. The same subject is handled by H. Diemer in "Factory Organization in Relation to Industrial Education," *Annals*, American Academy of Political and Social Science, vol. 44, p. 130.

[1] *Scientific Management in Education*. 282 pp. (New York and Philadelphia. Hinds, Noble & Eldredge, 1913.)

[2] *Bricklaying System*. (New York and Chicago, 1909.)

[3] "The Application of the Taylor System to Gas Works," *American Gas Light Journal*, vol. 95, p. 225, and *Progressive Age*, vol. 29, p. 830.

[4] "Scientific Management in the Army and Navy," *World's Work*, vol. 23, p. 311.

and by Lieutenant-Commander W. B. Tardy.[1] Particularly interesting is the *Report* of the Civilian Expert Board [2] on Industrial Management of United States Navy Yards. This Board, appointed by the Secretary of the Navy, and consisting of Messrs. H. L. Gantt, Harrington Emerson, and Charles Day, investigated the present functions and conditions of navy yards. They discussed the efficiency of their management in comparison with that of industrial plants and made certain recommendations in regard to the nature of the work properly to be performed in navy yards and "that scientific management be introduced and perpetuated in the navy yards which it is decided to operate." Former Secretary George von L. Meyer [3] seems to have favored this development.

Mr. Wilfred Lewis, in "Conserving the Data of Scientific Management,"[4] suggests the opportunities for colleges to assist in securing

[1] "A Plea for a Standard Organization of the Engineer Division Aboard Ship," etc., *Journal*, American Society of Naval Engineers, vol. 23, p. 681.

[2] Prepared by direction of Hon. George von L. Meyer, Secretary of the Navy. (Washington, 1912.)

[3] "The Business Management of the Navy," *Scientific American*, December 9, 1911, vol. 105, p. 513. See also editorial, "Scientific Management on Sea and Shore," *Scientific American*, June 3, 1911, vol. 104, p. 542.

[4] *Iron Age*, December 5, 1912, vol. 90, pp. 1324–25.

and participating in the results of scientific management investigations.

The most ambitious attempt to apply the Taylor principles to selling has been made by Mr. Charles W. Hoyt.[1] He describes such modern methods as training classes, salesmen's conventions, standardized talks, and he outlines rather inadequately the application of the scientific method of approach to the problems of salesmanship.[2] A good description of the methods of routing salesmen employed in a well-known scientific management plant is given by Mr. H. W. Brown.[3]

The growing realization that perhaps the greatest economic waste from which we suffer is due to the inefficient management of household economy has resulted in some attention being given to the working of the Taylor principles in domestic management. Perhaps the most thoughtful book on this subject is that of

[1] *Scientific Sales Management.* (New Haven, 1913.)

[2] Other articles dealing briefly with this subject are Mr. Amasa Walker's "Scientific Management Applied to Commercial Enterprises," *Journal of Political Economy*, vol. 21, p. 388, and Mr. J. George Frederick's "Applying the Science of Management to Selling," *Industrial Engineering*, vol. 12, p. 204. See also Enrico Alfredo Masino, "I Sistema Taylor Applicato alle Imprese Commerciali," *Rivista delle Societa Commerciali*, Fasc. 8–9. (Roma, 1913.)

[3] "Scientific Handling of Salesmen," *Industrial Engineering*, October, 1914, vol. 14, no. 3, p. 358.

Mrs. Mary Pattison, "Principles of Domestic Engineering,"[1] which builds up from the fundamental concept of the nature and purpose of the home and includes some of the results of her work at the Housekeeping Experiment Station at Colonia, New Jersey. Another stimulating book on the subject is that of Martha B. and Robert W. Bruere,[2] and there is a good article by Lucy M. Griscom in the *Journal of Home Economics*.[3] A most suggestive article is that by Mr. J. B. Guernsey,[4] which, however, is rather too vague and theoretical to be of practical service.

A widespread interest in scientific management has led to the consideration of its application, of course in modified form, to the profes-

[1] Colonia, New Jersey, 1915.

[2] *Increasing Home Efficiency*. (New York, The Macmillan Co., 1912. 318 pp.)

[3] "The Elimination of Waste in the Household," *Journal of Home Economics*, June, 1910, vol. 2, pp. 292–97.

[4] "Scientific Management in the Home," *Outlook*, vol. 100, p. 821, keenly criticized in "Scientific Management in the Home," *ibid.*, vol. 102, pp. 72–74. See also H. P. T., "Housekeeping as a Business," *ibid.*, June 8, 1912, vol. 101, pp. 303–05; Francis E. Leupp, "Scientific Management in the Family," *ibid.*, August 12, 1911, vol. 98, pp. 832–37; Frank B. Gilbreth, "Scientific Management in the Household," *Journal of Home Economics*, December, 1912, vol. 4, pp. 438–47; and M. Atkinson, "The Application of Scientific Methods to Housekeeping," *Living Age*, October 24, 1908, vol. 259, pp. 227–33. On page 240 will be found references to the application of time and motion studies in household management.

sions. Professor W. F. Ostwald [1] shows where it may be useful to scientists in their work. Dean Shailer Mathews [2] indicates how church management may profit by it, and H. W. Jessup [3] uses it with considerable effect in a severe criticism of judicial methods.

It is not strange that the best-known and most popular books on the principles of scientific management are not those written by its originator and his co-workers; they are the product of persons who have been influenced by them and whose gift of expression is more highly developed. Foremost among these are two books by Mr. Harrington Emerson,[4] marked by a breadth of interesting information, and a capacity for inspiring, almost poetic, elucidation, which have made them the most popular expositions of the subject.[5]

[1] "Scientific Management for Scientists," *Scientific American*, January 4, 1913, vol. 108, pp. 5–6.

[2] *Scientific Management in the Churches.* (Chicago, University of Chicago Press, 1912. 66 pp.)

[3] "Legal Efficiency," *Bench and Bar*, March, 1913, vol. 4, pp. 55–68.

[4] *Efficiency* (New York, 1910), and *The Twelve Principles of Efficiency* (1912).

[5] Three other simplified expositions worth mentioning are *The Primer of Scientific Management* (New York, 1912), by Mr. F. B. Gilbreth; *The Psychology of Management* (New York, 1913), by Mrs. L. M. Gilbreth; and an excellent presentation by Lauritz A. Larsen, *Scientific Management.* (New York, Alexander Hamilton Institute, 1911.)

Mr. Emerson discusses certain typical inefficiencies and their significance, the causes of national industrial prosperity, the strength and weakness of existing systems of organization. He then proceeds to an exposition of his own method of line and staff organization, the determination and realization of standards, cost accounting, the location and elimination of wastes, and the Emerson bonus system. His method differs from that of Mr. Taylor in two respects: in the first place, in the line and staff organization, the staff consisting of the experts occupies an auxiliary and advisory relation to the management, whereas in the Taylor System, the experts are the functional foremen and are an integral executive part of the organization; in the second place, the Emerson bonus proceeds on the rough determination of a standard efficiency which he calls one hundred per cent; the workman who attains sixty-seven per cent or less gets his guaranteed day wages, and is paid a bonus on a sliding scale for every increase in the percentage of efficiency; at one hundred per cent the bonus amounts to twenty per cent of his wages and one per cent is added for each additional one per cent of efficiency. As the task is not originally so accurately and thoroughly set as in the Taylor System, the

workman can, and frequently does, exceed the one hundred per cent mark.

Mr. Emerson states the principles of management as follows: (1) clearly defined ideals; (2) common sense; (3) competent counsel; (4) discipline; (5) the fair deal; (6) reliable, immediate, and adequate records; (7) dispatching; (8) standards and schedules; (9) standardized conditions; (10) standardized operations; (11) written standard-practice instructions; (12) efficiency reward. Most of these are not by any means peculiar to scientific management, nor can it be said that Mr. Emerson's application of them is distinctively original. Incidentally it is interesting to note the gradual change from Mr. Emerson's acknowledgment of indebtedness to Mr. Taylor, in certain discussions in the American Society of Mechanical Engineers, to the reversal of this position in his later published work. Mr. Emerson has made characteristic suggestions for the application of his principles to waterworks,[1] high schools,[2] and many other activities.

Within the last few years an extensive liter-

[1] "The Principles of Efficiency Applied to Waterworks." *Proceedings*, American Waterworks Association, 1912.

[2] "Scientific Management and High School Efficiency," *Official Bulletin* High School Teachers' Association of New York City, no. 35, November 9, 1912.

ature on the general principles and methods of scientific management has been growing up in Europe. The best analysis of principles is that to be found in the various publications of the distinguished French engineer, M. LeChatelier.[1]

Another French engineer, M. de Freminville, has investigated the subject in the United States and published his results with illuminating comments.[2] A German engineer, Hugo Borst, also visited the States and reported his conclusions in an interesting address.[3] Professor Wallichs has given considerable publicity to the methods of the Taylor System as he derived them from Mr. Taylor's books.[4] In a long list of articles based on such knowledge as may come from reading on the subject may be

[1] *Organisation Scientifique, Principes et Application.* (Dunod et Pinat, Paris, 1915.) See also LeChatelier, *Revue de Metallurgie,* vol. XII, April, 1915, which contains reprints of a number of articles as a memorial to Mr. Taylor.

[2] "Le Système Taylor, Mémoires," *Bulletin,* Société d'Encouragement pour l'Industrie Nationale (March, 1914, Paris), and "Le Système Taylor et L'Organisation Scientifique de Travail dans les ateliers," *La Réforme Sociale,* March, 1914, vol. 67, p. 321.

[3] *Das Sogennante Taylor-System.* (Stuttgart, 1914.)

[4] "Moderne Amerikanische Fabrikorganisationen (System Taylor), Technik und Wirtschaft," *Monatschrift des Vereines Deutscher Ingenieure.* (V Jahrgang, 1912, Heft. I. Berlin); "Erhöhung der Wirtschaftlichkeit dürch Moderne Arbeitsverfahren (System Taylor)," *Armierter Beton* (VI Jahrgang, January, 1913, Berlin); and "Amerikanische Grundsätze der Betriebsleitung," *Der Tag,* December 8, 1911.

mentioned especially those of A. C. Allingham,[1] Wilhelm Wirz,[2] G. Schlesinger,[3] S. Valenti Camp,[4] A. Voight,[5] Rudolph Seubert,[6] and Gine Scanferla.[7] All these are significant mainly for their showing of the widespread interest in the new industrial doctrines.[8]

Out of the large number of books written within the last five years on the general subject of factory administration, four of the most important devote attention to a discussion of scientific management and show in general considerable influence by it. The most noteworthy

[1] "Scientific Shop Management on the Taylor System," *Proceedings*, Junior Institution of Engineers, November and December, 1912, London.

[2] "Taylors Betriebsystem" (Zurich, 1913); and "Taylors Betriebsystem," *Zeitschrift für Handelswissenschaft und Handelspraxis* (1913, H. 5, p. 133).

[3] "Practical and Scientific Management: The Taylor System from the Viewpoint of a German Engineer," *Industrial Engineering*, September, 1913, vol. 13, pp. 376–80.

[4] "Indagaciones y Lecturas; La Direccion Cientifica del Trabajo Humano," *Estudio*, vol. VII, p. 232, August, 1914.

[5] "Taylors System in Deutschland," *Elsässisches Textil-Blatt*, July 1–8, 1913.

[6] *Amerikanische Fabrikorganisation nach System Taylor*. 1911.

[7] "Note sul sistema Taylor per l'organizzazione del lavoro nelle officine," *Industria*, December 15, 1912.

[8] For a collection of articles covering the theory and some details of the practice of scientific management, from American sources mainly, see C. B. Thompson's *Scientific Management* (Harvard University Press, Cambridge, 1914); and the reviews of the same in the *Nation* (New York), December 10, 1914; and J. S. H., "Industrial Efficiency," *Protectionist*, December 4, 1914, p. 542, vol. 26, no. 8.

of these are by Mr. Charles B. Going,[1] Mr. Dexter Kimball,[2] and Mr. A. Hamilton Church[3] — these are especially valuable for the setting they give scientific management in the development of modern administrative methods. Messrs. Galloway, Hotchkiss, and Mayor,[4] Hugo Diemer,[5] Norris A. Brisco,[6] J. Russell Smith,[7] Oscar E. Perrigo and Hugo Diemer,[8] and Frederick A. Waldron,[9] have published books and articles on the general principles of factory management, showing very strongly the influence of the Taylor and allied systems.

It is natural that such a radical and far-reaching movement as scientific management should meet criticism. It has in fact been a veritable storm-center. Much of the criticism

[1] *Principles of Industrial Engineering.* (New York, 1911.)

[2] *Principles of Industrial Organization.* (New York, 1913.)

[3] *Science and Practice of Management.* (Engineering Magazine Company, New York, 1914.) Reviewed in *Manufacturers' Record*, October 29, 1914, vol. 66, p. 63.

[4] *Business Organization.* (New York, 1912.)

[5] *Factory Organization and Administration.* (New York, 1910.)

[6] *Economics of Efficiency.* (New York, 1913.)

[7] *Elements of Industrial Management.* Reviewed by C. B. Thompson in *American Economic Review*, vol. VI, p. 377, 1916.

[8] "Raising the Efficiency of Men and Machinery," *System*, April, June, September, 1906.

[9] "Modern Methods of Shop Management," *Iron Age*, April 28, 1910.

is aimed at details and will be discussed later; but the following articles go for the system root and branch and should properly be enumerated here. The most comprehensive criticism is that by Admiral John R. Edwards,[1] who sums up the comments of most of the adverse writers, and adds on his own account that scientific management does not cover the whole of management, and that in any case management is an art rather than a science, that the Taylor System antagonizes the workmen and neglects the personal equation, and that whatever advantages have come from it have been incidental by-products. Another severe criticism is that by Mr. A. Hamilton Church,[2] who attacks particularly certain extracts from Mr. Taylor's writings, leading to the conclusion that Mr. Taylor does not show a science.[3] Mr. Church and Mr. L. P. Alford [4] undertook to enumerate the principles of management and pointed out the place of the Taylor System in

[1] "The Fetishism of Scientific Management," *Journal*, American Society of Naval Engineers, vol. 24, p. 355.

[2] "Has Scientific Management Science?" *American Machinist*, vol. 35, p. 108.

[3] The same point is made in an editorial called "The Science of Management Defined, and the Scope of this Science," *Engineering and Contracting*, vol. 39, p. 339.

[4] "The Principles of Management," *American Machinist*, vol. 36, p. 857. Reviewed by Mr. D. S. Kimball and Mr. J. Calder, *ibid.*, p. 965.

them.[1] Mr. Waldron [2] has indicated what seems to him the insufficient attention the Taylor System has given to the balancing of functions. The system is severely criticized by Mr. John Calder.[3]

As already stated, most of the popular articles on the subject are obviously journalistic and ephemeral. The most spectacular discoveries of Mr. Taylor and his co-workers lend themselves easily to "popular" treatment; and the possible results of the application of the stop-watch and the micrometer appeal effec-

[1] Other important general criticisms are those by Mr. Dexter S. Kimball, "Another Side of Efficiency Engineering," *American Machinist*, vol. 36, p. 263, developing briefly some of the social and economic implications of the movement and calling attention to the absence of a discussion of distribution; by H. G. Bradlee, "A Consideration of Certain Limitations of Scientific Efficiency," in *Technology and Industrial Efficiency*, p. 190 (New York, 1911); reprinted in Stone & Webster's *Public Service Journal*, vol. 8, p. 323, pointing out that for the most effective application conditions must be uniform, work repetitive, and the area of operations small; by Mr. E. C. Peck, "Systematic versus Scientific Management," *Iron Age*, vol. 88, p. 364, drawing attention to the scarcity of real experts and the dangers of inexpert work; and by Mr. James R. Johnson, "A Manager's View of the Taylor System," *American Machinist*, vol. 34, p. 885, representing the point of view of the typical successful manager, that we should let well enough alone. See also "Industrial Management," *Engineering*, June 27, 1913; and "Management as seen by the British Technical Press," *American Machinist*, vol. 40, no. 6, pp. 257–58.

[2] "Factors of Management other than Labor," *American Machinist*, February 13, 1913, vol. 38, pp. 276–78.

[3] "Overvaluation of Management Science," *Iron Age*, March 6, 1913, vol. 91, pp. 605–06.

tively to the imagination of magazine and newspaper writers. Most of their work contains nothing new or significant. A conspicuous exception to this is a series of articles under the caption "The Golden Rule in Business," published by Miss Ida M. Tarbell in the *American Magazine* at intervals during 1914, 1915, and 1916. The few popular articles of real value are listed below.[1]

[1] The following contain good enough ideas, well enough expressed, to warrant listing and recommending them: Mr. A. G. Popke's "The Relations of Capital, Labor and Efficiency in Manufacturing," *Engineering Magazine*, vol. 43, p. 857, pointing out the necessity of increasing efficiency; Mr. E. Perry's "The Outsider and the Busy Business Man," *ibid.*, vol. 40, p. 249, answering the old saw that improvement should come from the inside and not from the outside expert; a series of articles by Mr. E. M. Wooley, — "The One Best Way," *System*, vol. 20, pp. 227, 356, 460, 614; "Scientific Management in the Office," *ibid.*, vol. 21, p. 3; "Getting Out the Mail," *ibid.*, vol. 21, p. 284; "The Wanton Waste of Labor," *ibid.*, vol. 21, pp. 13, 173; "Lost Motions in Retail Selling," *ibid.*, vol. 21, pp. 366, 465, — well written and suggestive; Mr. H. S. Philbrick's "Scientific Management," *World To-day*, vol. 21, p. 1167, developing the idea that scientific management is a resumption of the direct oversight over production which had gradually vanished; an anonymous article, "What is Scientific Management, and What Does it Do?" *Industrial Engineering*, vol. 9, p. 1; an article, also anonymous, on "Efficiency Program," *Independent*, vol. 70, p. 739; an anonymous article entitled "Aspects of Scientific Management," *Nation*, vol. 92, p. 464: and an excellent article by Mr. F. B. Copley, "How it Works: What Manufacturers and Workmen are Getting out of Scientific Management," *American Magazine*, vol. 75, p. 11, summarizing the results of an extensive investigation and approved personally by Mr. Taylor. Other articles are listed in italics without comment in the Bibliography, p. 271.

2. Scientific Management in Operation

As yet little has been published summarizing the results of the application of scientific management in any large proportion of the plants which are using it. The nearest approach to a complete review of its present status is in the Report of the Sub-Committee on Administration of the American Society of Mechanical Engineers, referred to above.[1] It is significant that one of the signers and, I believe, the actual writer of this report, is Mr. L. P. Alford, mentioned above as one of the critics of the movement. Mr. Alford has written another excellent article,[2] based on the experience of a well-known Philadelphia company. Mr. G. D. Babcock, production manager of the Franklin Automobile Company, has published an excellent statement of the methods and results of the system in that plant.[3] Mr. A. W. Shaw, editor of the magazine *System*, gives a good brief re-

[1] See also Symposium on "What Efficiency Means," *Independent*, November 30, 1914, vol. 80, no. 3443, which includes expressions from C. W. Eliot, L. D. Brandeis, J. P. Mitchell, F. A. Vanderlip, C. H. Gary, and others. See also a brief description by A. Wallichs, in "Eindrücke vom Amerikanischen Maschinenbau," *Werkstattstechnik*, 1912, Heft. 1. Berlin.

[2] "Scientific Management in Use," *American Machinist*, vol. 36, p. 548.

[3] "Results of Applied Scientific Management," *Iron Age*, vol. 93, pp. 1402, 1454, 1512, 1572; vol. 94, pp. 14, 90, 134. *American Machinist*, vol. 40, no. 25, pp. 1063–68.

view,[1] describing the work of the system at the Tabor Manufacturing Company in Philadelphia, and suggesting the method of its application to business problems in general and the results that might reasonably be expected from it. The experience of the Link Belt Company of Philadelphia is described by Mr. James M. Dodge, its late chairman [2] and a complete and detailed explanation of the operation of the Taylor System in that plant is given by Lieutenant Frank W. Sterling.[3] The experience of the same plant is the basis of an article by Mr. C. W. Adams, its superintendent.[4] The same methods, as worked out by the Midvale Steel Company, are described by Mr. H. L. Arnold.[5] An excellent description of the early application of the system at the Bethlehem Steel Works is published by Mr. H. L. Gantt,[6] and the story

[1] "Scientific Management in Business," *Review of Reviews*, vol. 43, p. 327.

[2] "A History of the Introduction of a System of Shop Management," *Transactions*, A.S.M.E., vol. 27, p. 720.

[3] "The Successful Operation of a System of Scientific Management," *Journal*, American Society of Naval Engineers, vol. 24, p. 167.

[4] "The Differential Piece Rate," *American Machinist*, vol. 34, p. 18. See also "Methods of Management that Made Money," *Industrial Engineering*, January, 1911, vol. 9, pp. 21–27.

[5] "Preëminent Success of the Differential Piece Rate System," *Engineering Magazine*, vol. 12, p. 831.

[6] "A Practical Application of Scientific Management," *Engineering Magazine*, vol. 41, p. 1.

of its introduction and results at the Tabor Manufacturing Company is told by Mr. Wilfred Lewis, the president of the company.[1] There is an interesting account of a premature experiment in a French company by Mr. Georges de Ram, a young French engineer who had had some experience in American plants.[2] The methods described in Mr. H. P. Kendall's paper [3] are in the main those of the large printing and binding establishment of which he is the general manager. Mr. Carl G. Barth gives an interesting anecdotal account.[4] Lieutenant-Commanders W. B. Tardy [5] and A. M. Cook [6] give the results of the application of the principles of the system to gunnery practice and to the administration of a navy yard. The same subject is also dealt with by Mr. Holden A.

[1] "An Object Lesson in Efficiency," in *Technology and Industrial Efficiency*, p. 173. (New York, 1911.)

[2] "Quelques Notes sur un Essai d'Application du Système Taylor dans un Grand Atelier de Mécanique Français," *Revue de Metallurgie*, September, 1909. Paris.

[3] "Management: Unsystematized, Systematized, and Scientific," *Scientific Management*, Tuck School Conference, 1912, p. 12. Abstract in *Industrial Engineering*, vol. 10, p. 374.

[4] "Betterment of Machine-Tool Operation by Scientific Metal Cutting," *Engineering Magazine*, vol. 42, p. 586.

[5] "Scientific Management and Efficiency in the United States Navy," *Engineering Magazine*, vol. 41, p. 545; *American Review of Reviews*, vol. 44, p. 229.

[6] "Scientific Management Methods at a Naval Magazine," *Engineering Magazine*, vol. 42, p. 75.

Evans in a series of articles.[1] The application to an automobile repair shop of the modification of the Taylor System used by Mr. Emerson and his disciples is described by Mr. A. Flack.[2]

Two extended and complete accounts are those by Mr. Charles B. Going and by General William Crozier. Mr. Going's article [3] describes the results achieved by Mr. Emerson in the application of his form of scientific management to the Santa Fé Railroad, and presents the conclusions of a disinterested spectator removed from the stress of the conflict between the railroad managers and their critics. It will be discussed in more detail in the next section. The reports by General Crozier on the application of the Taylor System to government arsenals [4] are exceptional in that they give detailed costs and comparisons to an extent not considered practicable by the managers of private concerns. The 1911 report gives an excel-

[1] "Reduction in Cost of Navy Yard Work," *American Machinist*, vol. 33, p. 1200; "General Instruction for Machine-Shop Methods," *ibid.*, vol. 31, p. 610; "Detailed Instruction for Machine-Shop Methods," *ibid.*, p. 645; "Do Taylor's Methods Increase Production?" *ibid.*, vol. 34, p. 1133; "Output under Scientific Management," *ibid.*, p. 1202.

[2] "Machine-Shop Experience with the Principle of Efficiency Reward," *Engineering Magazine*, vol. 41, p. 641.

[3] "The Methods of the Santa Fé," *Engineering Magazine*, vol. 36, p. 909; vol. 37, pp. 9, 225, 337, 541.

[4] *Reports of the Chief of Ordnance*, 1911, 1912, 1913, and 1914. (Government Printing Office, Washington.)

lent brief résumé of the introduction of the system in the Watertown Arsenal, and a rather full demonstration of the statement that "the practical effect of these methods at the Watertown Arsenal has been a material reduction in the cost of general manufacture at that place," and describes the beginning of the trouble at that arsenal with the molders and machinists. The 1912 report pursues the same subject and quotes comparisons of the cost of production at Watertown and other arsenals where the system had begun to be installed with bids on the same items from outside concerns. The appendix to the 1913 report gives the recent petition of the Watertown employees for the abolition of the Taylor System, and the extended and conclusive reply of General Crozier.

Accounts of a tentative application of scientific management to municipal and governmental work are found in the reports of the Milwaukee Bureau of Economy and Efficiency[1] and in the report of the President's Commission on Economy and Efficiency.[2]

[1] Bulletin no. 19, *Eighteen Months' Work*, Milwaukee, Wis., April 15, 1912. 44 pp. Bulletin no. 20, *Garbage Collection*, Milwaukee, Wis., January 15, 1912. 24 pp.

[2] Washington, D.C., Superintendent of Documents, 1913. See also an article by Fred H. Colvin, "Management at Watertown Arsenal," *American Machinist*, September 12, 1912, vol. 37, pp. 424–27.

3. Scientific Management and the Railroads

In the Eastern Rate Case, the application of the railroads to the Interstate Commerce Commission for permission to raise freight rates was met by the shippers, under the advice of Mr. Louis D. Brandeis, now Associate Justice of the Supreme Court of the United States, with the counter-argument that, instead of raising the rates to spend more money, they should make their operation efficient to get more out of their present expenditure. In the course of the hearings, the following testimony was introduced:—

Mr. Brandeis. You have been quoted, Mr. Emerson, as stating that in your opinion, by the introduction of proper efficiency system of scientific management, the railroads of the United States could effect an economy of perhaps $300,000,000 a year, or not less than $1,000,000 a day.

Mr. Emerson. That is correct — that is, I have been quoted as having stated that.

Mr. Brandeis. Is it your opinion that that is the fact?

Mr. Emerson. At least that.[1]

Although, as stated above, the decision of the Commission was not affected by this testimony,

[1] Brief on Behalf of Traffic Committee of Commercial Organizations of the Atlantic Seaboard, before the Interstate Commerce Commission, *re* Investigation of Proposed Advances in Freight Rates by Carriers in Official Classification Territory, p. 92.

the publicity it received stirred up an intense discussion, much of which on the part of the railroads showed signs of the spirit of the man who has been stung. This attitude was due, at least partly, to a highly sensational article in a popular magazine,[1] and is fairly well represented in an address by Mr. Howard Elliott, late president of the New York, New Haven & Hartford Railroad.[2]

The best summary of the testimony bearing on this subject is by Mr. Louis D. Brandeis,[3] who has analyzed the meaning, the requirements, and the effects of scientific management, and who groups the evidence of the witnesses in accordance with the analysis. In an earlier article [4] Mr. Harrington Emerson had pointed out that, in his opinion, the railroads could save $300,000,000 a year, and his articles [5]

[1] C. Moffett, "Saving $1,000,000 a day for American Consumers," *Hampton's Magazine*, March, 1911, vol. 26, pp. 346–56.

[2] *Efficient Railway Management.* (St. Paul, Minn., 1911.) 7 pp. Railway Library, 1910, Chicago, 2d series, pp. 110–13.

[3] *Scientific Management and Railroads.* (New York, 1911.) Ably reviewed by Mr. Edward D. Jones in the *American Economic Review*, vol. 1, p. 833.

[4] "Preventable Wastes and Losses on Railroads," *Railway Age Gazette*, vol. 45, p. 12.

[5] "How Railroad Efficiency can be Measured," *Engineering Magazine*, vol. 42, p. 10; and "The Methods of Exact Measurement Applied to Individual and Shop Efficiency at the Topeka Shops of the Santa Fé," *American Engineer and Railroad Journal*, vol. 81, p. 221. Mr. Emerson's work in the Santa Fé workshops is praised by Mr. W. J. Cunningham in the discussion of

suggest the method by which he approaches this conclusion. Mr. Emerson had been retained by the Santa Fé to develop his form of scientific management in part of their work, and the results are described by Mr. Charles B. Going,[1] who outlines the problems of the road and describes Mr. Emerson's treatment of the stores-keeping, shop-order, and works-order systems, maintenance of motive power, the bonus system, the apprentice system, and relations with the employees. The bonus system is further described by Mr. Fred H. Colvin, editor of the *American Machinist*.[2]

Mr. Taylor's address on scientific management before the New England Railroad Club (October 10, 1911). The following articles are also of interest in this connection: David Van Alstyne, "Efficient Shop Management," *Railway Age Gazette*, May 5, 1911, vol. 50, pp. 1051–53; F. L. Jandron, "Efficiency and the Railway Wage Problem," *Engineering Magazine*, November, 1912, vol. 44, pp. 241–47; Clarke J. Morrison, "Factors Influencing Railway Operating Efficiency," November, 1911, vol. 42, pp. 241–50.

[1] *Methods of the Santa Fé*. (Engineering Magazine Company, New York.)

[2] "How Bonus Works on the Santa Fé," *American Machinist*, vol. 36, pp. 7, 165. See also two articles by Mr. Charles H. Fry, associate editor of the *Railway Age Gazette*, in that magazine, vol. 41, pp. 476, 504, followed by an editorial on the same subject, vol. 45, p. 413. Mr. Fry outlines the organization of the work on that road and illustrates with charts and statistics the results attained, particularly in machine-shops.

It is generally understood that the influence of Mr. Emerson pervades the book of Mr. H. W. Jacobs, *Betterment Briefs* (New York, 1909, 2d ed.), dealing with Santa Fé machine shop improvements; reviewed in the *Railway Age Gazette*, vol. 47, p. 1192.

Severe criticism of Mr. Emerson and his methods was made by Mr. Wilson E. Symons.[1] Mr. Symons attacks Mr. Emerson's statistics, shows the impossibility, in his opinion, of a million dollars a day saving, denies that Mr. Emerson's work on the Santa Fé was of any value, and gives examples of what he considers real railroad efficiency. Whatever may be the worth of Mr. Symons's statistics, it is evident to any one acquainted with scientific management that he knows practically nothing of the latter subject, and the paper is valuable mainly by reason of the discussion participated in by many well-known railroad men.[2]

The bitterness of the reaction by some rail-

[1] "The Practical Application of Scientific Management to Railway Operation," *Journal*, Franklin Institute, vol. 173, pp. 1, 140, 271, 365. See also his reply to an editorial criticism of his own paper in the *Railway Age Gazette*, vol. 51, p. 1107.

[2] In the same journal appeared a defense of Mr. Emerson by Mr. C. J. Morrison, "Letter on Scientific Management" (*Railway Age Gazette*, vol. 50, p. 214), and a fair criticism with acknowledgment of variation of the Emerson and the Taylor methods in an anonymous article on "What is Scientific Management?" (*ibid.*, vol. 50, p. 839). Two good editorials on the subject are contained in the *Railway Age Gazette:* one of which (vol. 50, p. 18) holds that "the basic principles underlying scientific management are correct," and the other (vol. 50, p. 210), that "the value and effectiveness of scientific time study cannot be questioned." Some justification of Mr. Emerson's criticism of the efficiency of the railroads may be found in an article by Mr. L. C. Fritch, a well-recognized railroad expert, on "Opportunities for Economy on Railways," *ibid.*, vol. 51, p. 1059.

road men is illustrated in a series of anonymous articles,[1] with such titles as "Extravagant Claims," "Impractical Theories," "Neglect of Human Element," "Unscientific Method and Impatience for Results," and "Neglect of Large Factors," which criticize severely some of the practices the writer had apparently met with. It is unfortunate that no means of identification are given, and there is apparently some point to the comment in the letter by Mr. F. L. Hutchins [2] to the effect that the writer of the articles was mistaken in his classification of "efficiency men." The articles are well worth reading, however, as they appear to describe accurately the kind of things done by the many ill-prepared and inexperienced practitioners of "efficiency."

The objection to scientific management on the railroads on the ground that interference of the labor unions makes it impossible, is voiced by Mr. J. O. Fagan,[3] who reiterates his point that the difficulty with the railroads is the employees.[4] There is also an illum-

[1] "The Mistakes of the Efficiency Men," *Railway Age Gazette*, vol. 50, pp. 29, 230, 391, 849, 1059.

[2] *Railway Age Gazette*, vol. 50, p. 268.

[3] "The Dream of Scientific Management on Railroads," *Journal of Accountancy*, vol. 12, p. 1.

[4] See also the discussion between Mr. Fagan and Mr. E. H. Abbott in "Humpty Dumpty's Question, and Its Answer,"

inating and fair discussion of this subject by Professor W. J. Cunningham, of Harvard University.[1]

Other fundamental objections to the application of scientific management to railroads are discussed by Professor Cunningham.[2] After stating the principles of the Taylor System, he discusses the testimony of Mr. Emerson and points out the vagueness of the methods proposed by him. He criticizes severely Mr. Emerson's statistics and particularly the method by which he arrives at the one million dollars a day saving. Acknowledging the success of scientific management in commercial undertakings, he points out four essential differences between manufacturing establishments and railroads: (1) area and extent of activity; (2) nature of

Outlook, vol. 97, p. 543. The subject is also dealt with in an anonymous article in the *Iron Age*, "Railroad Efficiency and the Labor Unions," February 23, 1911; and the responsibility for the problem is traced in an anonymous article, "Genesis of Railway Brotherhoods," *Railway Age Gazette*, vol. 50, p. 782; the point is also mentioned by Mr. W. D. Hines in "Scientific Management for Railways," *Nation*, vol. 91, p. 576.

An excellent example of the official attitude of the organized railroad employees may be found in an article by the President of the Brotherhood of Locomotive Engineers, Warren S. Stone, *Efficiency as the Employee Sees It* (Railway Library, 1911, Chicago), pp. 216–24.

[1] "The Railroad Question: Brotherhoods and Efficiency," *Atlantic Monthly*, September, 1909, vol. 104, pp. 289–302.

[2] "Scientific Management in the Operation of Railroads," *Quarterly Journal of Economics*, vol. 25, p. 539.

product and output; (3) relations with the public and the Government; and (4) relations with labor unions, — any one of which, in his opinion, makes an application of the system to railroads impracticable. He then shows that the railroads have in fact for some time been applying scientific management of their own kind, and that the remedy for their administrative difficulties lies in a further application of the same methods by better and more efficient men.

Another railroad man, Mr. C. de L. Hine, in a stimulating and suggestive book,[1] develops the thesis that specialization has already been carried too far on the railroads and that what they need is decentralization rather than the increased centralization characteristic of scientific management.[2]

One of the principal arguments of the railroads was that, so far as scientific management was applicable to railroading, it was already being applied, as was pointed out in Mr. Cunningham's article already referred to. An attentive study of the examples given by the railroad writers, however, shows that in the main

[1] *Modern Organization.* (New York, 1912.)

[2] Attention should also be called to two editorials in the *Railway Age Gazette*, vol. 50, p. 265 and p. 387.

they have mistaken isolated applications of scientific methods for the systematized organization of administration, which is meant by "scientific management." [1]

In the mean time, practical heed is being given to the possibility of making some form of application of the new system to railroading. For obvious reasons little is being published on this point, and any reference to the fact that the methods are those of Mr. Taylor or Mr. Emerson is carefully avoided.[2]

The fact seems to be, as expressed [3] by Mr. C. C. Leech, that "the efficiency men simply got in wrong," and that when personalities came to be forgotten, the railroad managers were as

[1] See Mr. C. B. Brewer's "Substitute for the Rate Increase," etc., *Scientific American*, vol. 104, p. 596; Mr. B. S. Hinckley's "The Scientific Thought Applied to Railroad Problems," in *Technology and Industrial Efficiency*, p. 181 (New York, 1911); Mr. S. M. Felton's "Scientific Management of American Railways," *ibid.*, p. 221; and an anonymous article, "The Comparative Merits of Functional and Geographical Systems of Organization," *Engineering News*, vol. 64, p. 692.

[2] This is shown in the articles by Mr. W. J. Harahan on "Scientific Management," *Railway Age Gazette*, vol. 50, p. 212; by Mr. M. H. C. Brombacher on "Application of Scientific Management to a Railway Shop," *ibid.*, vol. 51, p. 23; by Messrs. H. F. Stimpson, L. W. Allison, J. S. Sheafe, and C. J. Morrison, on "Application of Scientific Management to a Railway Shop," *ibid.*, vol. 51, p. 33; and by Mr. B. A. Franklin on "An Efficiency Experiment Station for the Railroads," *Engineering Magazine*, vol. 42, p. 1.

[3] "A Letter on Efficiency," *Railway Age Gazette*, vol. 51, p. 221.

alive as any one to the possibilities of improvement.[1] As evidence of the truth of this[2] may be cited the work in the Canadian Pacific shops, where scientific methods have been installed by Mr. Gantt and maintained and developed by Mr. Vaughan, a leading railroad expert.[3] Mr. Colvin[4] described the same work and Mr. Zepp[5] shows how scientific management has been applied abroad in a large railway car factory. Accounts of applications on the

[1] An anonymous article, "Scientific Management of Railway Shops," *Machinery*, vol. 10, p. 16, calls attention to the steps taken by railroads to investigate efficiency as a result of the agitation; and an editorial in *Engineering and Contracting*, "The Railways and Scientific Management," vol. 35, p. 379, points out that scientific management is now being applied to the railroads.

E. R. Dewsnup, "Freight Car Efficiency," Western Railway Club, *Official Proceedings*, 1907–08, shows the need of a statistical study of car accounting, interchange and equipment, and points out the failure to attack and solve real problems. E. H. De Groot, "The Switching Factor in the Efficiency Problem," St. Louis Railway Club, *Proceedings*, June 9, 1911, vol. 16, pp. 21–24, discusses the current inefficient lay-out of tracks from the same point of view.

[2] In spite of the conclusion by Mr. George J. Burns, in "Notable Efficiencies in Railway Machine-Shop Operation," *Engineering Magazine*, vol. 42, pp. 161, 386, 616, that the setting of standards in a railroad shop is impossible.

[3] "Canadian Pacific Shop Management," *American Machinist*, vol. 35, p. 1164; and "Scheduling Locomotive Repair Work on the Canadian Pacific Railway," *Industrial Engineering*, vol. 8, p. 380.

[4] "Time-Saving Railroad Shop Methods," *American Machinist*, October 5, 1911, vol. 35, pp. 628–31.

[5] "Letter on Efficiency," *Railway Age Gazette*, vol. 51, p. 643.

Frisco Road [1] and in the shops of the Milwaukee Electric Railway [2] have also been published.

4. Methods

In current discussions of scientific management so much emphasis has been laid upon such things as time study, motion study, functional foremanship, instruction cards, and slide rules, that there is serious danger of these mechanisms of the system being taken for the system itself. With the warning, however, that detailed methods, either separately or in mere aggregation, are not scientific management, it is worth while to report the best of the articles and books which have appeared describing these methods. Nor is it superfluous to warn readers of these articles that the methods dealt with are so technical in their nature that their successful practice requires not only an expert in the methods used, but an expert in the proper adjustment of these methods to each other and particularly to the entire spirit of scientific management.

There is an excellent series of articles dealing

[1] "Mechanical Department Progress on the Frisco," *Railway Age Gazette*, November 6, 1914, vol. 57, pp. 845–50.

[2] "Efficiency Engineering in the Shops of the Milwaukee Electric Railway," *Electric Railway Journal*, March 21, 1914.

with the method of approach to the system,[1] most of which are amplifications of the warnings so liberally scattered through Mr. Taylor's own books. The point of all of them is that no management should undertake to develop the Taylor System in its plant, unless it is prepared for a very considerable expenditure of time, money, and effort and a slow process of mental revolution on the part of itself and its employees.

Of the growing shelfful of books on the entire subject, the best is, of course, Mr. Taylor's *Shop Management* referred to above. This book

[1] The best of these are Mr. James M. Dodge's "The Spirit in which Scientific Management should be approached," *Scientific Management*, Tuck School Conference, p. 142; abstract in *Industrial Engineering*, vol. 10, p. 350; Mr. H. K. Hathaway's "Prerequisites to the Introduction of Scientific Management," *Engineering Magazine*, vol. 41, p. 141. Attention may also be called to C. Bertrand Thompson's "How the Taylor System Works," *Factory*, November, 1914, vol. 13, p. 325; *ibid.*, December, 1914, vol. 13, p. 409; Henry P. Kendall, "The Attitude of Management and Men," *Industrial Engineering*, May, 1913, vol. 13, pp. 201–02; F. W. Taylor, "Changing from Ordinary to Scientific Management," *ibid.*, vol. 11, p. 267; George F. Card, "Scientific Management," *American Machinist*, March, 1912. The editor has an excellent editorial in *Industrial Engineering* on "Installation of Scientific Management," vol. 10, p. 301; and there is a good article in the *Iron Age* by Mr. E. M. Taylor, "Modern Methods and the Business Specialist," vol. 84, p. 184. There is a suggestive and humorous account of the way not to do it, called "Echoes from the Oil Country," by Mr. W. Osborne, *American Machinist*, vol. 34, p. 1036; and another by Mr. H. K. Hathaway, in the discussion of Mr. Taylor's "Art of Cutting Metals," *Transactions*, A.S.M.E., vol. 28, p. 281.

deals mainly with machine-shop practice, but the principles and methods are developed in such a way that their application to other types of industry is not difficult if made by those sufficiently trained. The book on *Concrete Costs* by Mr. Taylor and Mr. Sanford E. Thompson, referred to above, applies scientific management to concrete construction. The other books detailing methods of application are written by men who have studied more or less with Mr. Taylor, or have been strongly influenced by his methods. One of the best of these is by Mr. F. A. Parkhurst,[1] which includes a series of articles reprinted from *Industrial Engineering*. The book includes an outline of the organization of a plant under scientific management, and detailed statements of the functions of all the principal functional foremen, an analysis of routing, stores systems and time study, a discussion of standardization and many illustrations of forms and appliances. The methods described are based on the practice of the Ferracute Machine Company, and differ only slightly from the approved practice of the original Taylor group. Another excellent book by Mr. Holden A. Evans, formerly Naval

[1] *Applied Methods of Scientific Management.* (New York, 1912.)

Constructor at the Mare Island Navy Yard,[1] deals particularly with machine-shop, smith-shop, and woodworking-shop methods, and illustrates reductions in cost accomplished by these methods in navy yards under the author's supervision. In addition to its treatment of costs, it is concerned mainly with such developments in the direction of scientific management as may be undertaken by a manager not specially trained in the Taylor methods.[2]

Perhaps the most complete description of detailed methods of scientific management, as at present practiced, is that published by myself.[3] There is an excellent description of some of the methods of the Tabor Manufacturing Company in a book by a young German engineer who studied for some time in that plant.[4] The methods of the Emerson type of scientific

[1] *Cost Keeping and Scientific Management.* (New York, 1912.)

[2] There is a good statement of underlying principles in Mr. Evans's article, "Scientific Factory Management," *American Machinist*, vol. 33, p. 1108. The A. W. Shaw Company has published a little book, *How Scientific Management is Applied* (Chicago, 1911), consisting of a series of reprints of *System* articles.

[3] C. Bertrand Thompson, *Report on Scientific Management.* (Chicago, A. W. Shaw Co., 1917.) Many of the articles in C. B. Thompson's *Scientific Management* (Harvard University Press, Cambridge, 1914) deal with detailed methods. See reviews in *Textile World Record*, November, 1914; *Manufacturers' Record*, October 29, 1914; *Engineering Record*, November 14, 1914.

[4] *Aus der Praxis des Taylor-Systems.* (J. Springer, Berlin, 1914.)

management are described in some detail by Mr. C. E. Knoeppel.[1]

The application of scientific management to foundries and machine shops is given in some detail by Mr. Knoeppel [2] in a series of articles reprinted from the *Engineering Magazine*. This is an interesting and well-written description of the application of scientific management as interpreted by Mr. Emerson and his disciples.[3]

Mr. Walter N. Polakov [4] has published a valuable series of articles on the scientific management of power plants and Mr. P. R. Moses [5] has also made contributions of value.

[1] *Installing Efficiency Methods.* (Engineering Magazine Company, New York, 1915.) Attention may be called, also, to a rather sketchy book by B. A. Franklin, *Experiences in Efficiency.* (Engineering Magazine Company, New York, 1915.)

[2] *Maximum Production in Machine-Shop and Foundry.* (New York, 1911.) See also Knoeppel, "Current Foundry Inefficiencies and Practices," *Foundry*, September, 1914; and Frederick A. Parkhurst, "Scientific Management in the Foundry," *American Institute of Metals*, September, 1914.

[3] Attention may be called to articles by Mr. Holden A. Evans, "Detailed Instructions for Machine-Shop Methods," *American Machinist*, vol. 31, p. 16, and "An Analysis of Machine-Shop Methods," *ibid.*, p. 568; and by Mr. Frederick A. Waldron, "Modern Methods of Shop Management," *Iron Age*, vol. 85, p. 982, which are almost too brief to be very useful.

[4] "Power-plant Betterment by Scientific Management," *Engineering Magazine*, April–September, 1911, vol. 41, pp. 102–12; 278–92; 448–56; 577–82; 796–809; 970–75.

[5] "Scientific Management in Isolated-plant Operation," *Engineering Magazine*, February, 1913, vol. 44, pp. 714–20; and "Scientific Management in Power-Plant Operation," *Engineering Magazine*, March, 1913, vol. 44, pp. 885–93.

The best articles describing the functions of the planning department are those by Mr. H. K. Hathaway,[1] in which he outlines briefly the duties of the functional foremen and illustrates the practical working of the extension of specialization to mental and supervisional work.

Perhaps the most distinctive feature of scientific management in the popular conception of the term is its time study. Current methods of time study, however, are frequently confused with the Taylor method. In ordinary practice watches are often used to determine roughly the time an operation usually takes, and the result is sometimes made the basis of a piece rate. This type of time study is known to the Taylor group as an "over-all" study and is never used by them. The Taylor method consists in the analysis of operations into their elementary units, the determination of the best methods and time for the performance of each of these

[1] "The Planning Department," *Industrial Engineering*, vol. 12, pp. 7, 53, and 97. With these should be read an anonymous article, "The Foreman's Place in Scientific Management," *Industrial Engineering*, vol. 9, p. 197; and the criticisms of functional foremanship in Mr. John Calder's "The Production Department," *Transactions*, The Efficiency Society, vol. 1, p. 155. Professor Dexter S. Kimball discusses the development and advantages of the Taylor form of functional organization in "Choosing a Form of Organization," *Factory*, July, 1914, vol. 13, p. 21.

units, and their summation into a total time for the entire job.

The best descriptions of elementary time study as practiced by the Taylor group of engineers are those by Mr. H. K. Hathaway,[1] Mr. H. W. Reed,[2] Mr. D. V. Merrick,[3] and Ralph W. Langley.[4] A comparison of these articles with the tables of operating times given in Babbage's *Economy of Manufactures* will effectively dispose of any claim that the Taylor methods were anticipated by Babbage.

Mr. Sanford E. Thompson, one of the early associates of Mr. Taylor, has contributed an interesting article of a more general nature on the same subject.[5] The sections of Taylor's *Shop Management* on time-study methods were written by Mr. Thompson.

The practice of time study involves motion

[1] "Elementary Time Study as a Part of the Taylor System of Scientific Management," *Industrial Engineering*, vol. 11, p. 85.

[2] "A Time Study under the Taylor System," *American Machinist*, vol. 35, p. 689. A good article is that by Mr. N. E. Adamson, Jr., "The Taking of Time Study Observations," *Industrial Engineering*, vol. 10, p. 439.

[3] "Making Instruction Cards from Time Studies — How Time Study as a Part of Taylor System is Analyzed — Establishing Standard Times," *Iron Age*, March 11, 1915, p. 560.

[4] "Notes on Time Studies," *Industrial Engineering*, September, 1913, vol. 13, pp. 385–87.

[5] "Time Study and Task Work," *Journal of Political Economy*, May, 1913, vol. 21, pp. 377–87.

study. The aim of motion study is to determine the most effective motion to accomplish a desired result; and one of the elements in the determination of its effectiveness is the time it takes to execute it. Time study and motion study, therefore, go hand in hand, but it is not impossible to make an effective and profitable motion study without the use of any timing device. There is an interesting foreshadowing of modern motion study in an experiment carried out in 1837. This was described by Th. Lefèvre,[1] a foreman in the famous printing plant of the Didots, who was struck with the fact that the traditional lay-out of the printer's case was not the one best adapted to the setting of type, in that usually the compositor had to reach farthest for the most frequently used letters. Lefèvre, therefore, redesigned the case with a view to the maximum economy of effort and, after a test of both lay-outs, adopted the revised case for his plant. After some years of struggle with the traditions of the printing fraternity, the new case was abandoned; but the experiment is a good early illustration of the application of motion study.

The best descriptions of motion study as such

[1] *Guide Pratique du Compositeur.* (Paris, 1883, nouvelle édition.)

are given by Mr. Frank B. Gilbreth.[1] Mr. Gilbreth endeavors to list the variables affecting the efficient performance of manual work, and to point out the extent of their influence. They are classed as variables of the worker, including anatomy, brawn, contentment, creed, earning power, experience, fatigue, habits, health, mode of living, nutrition, size, skill, temperament, and training; variables of the surroundings, including appliances, clothes, color, entertainment, heating, lighting, quality of material, rewards and penalties, size of unit moved, special fatigue-eliminating devices, surroundings, tools, union rules, and weight of unit moved; variables of the motion, including acceleration, automaticity, combination with other motions, cost, direction, effectiveness, foot-pounds of work accomplished, inertia and momentum overcome, length, necessity, path, play for position, and speed. The application of motion study to operations so small that they cannot be noted by the human eye unaided is accomplished by means of moving pictures.[2]

[1] *Motion Study.* (New York, 1911.) See also chap. XIV of his *Bricklaying System.* (New York & Chicago, 1909.)

[2] "Micro-Motion Study — a New Development in Efficiency," *Scientific American*, vol. 108, p. 84. An illustration of the kind of results achieved is given by Mr. H. L. Gantt, "'Hipped' on Motion Study," *Industrial Engineering*, vol. 8, p. 307, and by Mr. William D. Ennis, "An Experiment in

Mr. Gilbreth has devoted a great deal of attention to the development of methods for the study and representation of motions.[1] Among the ingenious appliances devised by him for this purpose should be mentioned his "chronocyclegraphs," the name he gives to photographs of motions taken by attaching small electric lights to the hands of the operators in such a way that the course of the motion is recorded by the light on the negative as a continuous line. By introducing a circuit-breaker the light may be made to flash at intervals of a second or any fraction thereof and the photograph of the flash indicates the direction of the motion.[2] On the basis of these photographs he has constructed "motion models," wire contrivances reproducing in three dimensions the lines in the photographs.[3] The appli-

Motion Study," *ibid.*, vol. 9, p. 462. Professor Walter D. Scott, "The Rate of Improvement in Efficiency," *System*, vol. 20, p. 155, presents a useful side-light on its application. The following articles show how it may be used in fields outside manufacturing: Mr. E. M. Wooley's "Lost Motions in Retail Selling," *ibid.*, vol. 21, pp. 366, 465, "Getting Out the Mail," *ibid.*, p. 284, and Mr. J. G. Frederick and Mr. H. S. McCormack's "Motion Study in Office Work," *ibid.*, p. 563.

[1] See Robert Thurston Kent, "Micro-motion Study in Industry," *Iron Age*, January 2, 1913, vol. 91, pp. 34–37.

[2] *Chronocyclegraph Motion Devices for Measuring Achievement.* Second Pan-American Congress, Washington, D.C., 1916.

[3] *Motion Models: Their Use in the Transference of Experience and the Presentation of Comparative Results in Educational*

cation of these studies to the reconstruction of work for soldiers crippled in the present war is indicated in two interesting articles.[1] In a recent book, *Fatigue Study*, there are further suggestions on the use and value of refined motion studies.[2]

Unfortunately, there is as yet no comprehensive study of industrial fatigue. Many investigators have been working on the subject of human and animal fatigue, but their experiments have been carried on almost exclusively in physiological laboratories. A mass of valuable data has been accumulated in this way, but there still remains an opportunity for some one familiar with the results of these researches to extend them to industrial conditions and determine the laws governing fatigue in industry. On the basis of such investigation practical rules may be developed for application to industrial and commercial conditions.

The statement sometimes made that the founders of scientific management had formulated the laws of fatigue is altogether too

Methods. American Association for the Advancement of Science, Columbus, 1916.

[1] "Motion Study for the Crippled Soldier," *Journal*, A.S.M.E., December, 1915, p. 669; "Motion Study for Crippled Soldiers," American Association for the Advancement of Science, 1916.

[2] *Fatigue Study*. (New York, 1916.)

broad. The element of truth in it lies in the fact that in certain specific instances the length of time during which a carrier of materials should be under load has been determined, as in the famous case of "Schmidt, the pig-iron handler," and in a number of instances rough determinations of the proportion and distribution of rest periods in the course of a day's work have been made.[1] In no instance, however, to my knowledge, has this work been carried on by any one properly equipped with the necessary knowledge of physiology and anatomy and of the present state of the science of fatigue.

Motion study is spectacular in its nature and deceptively easy to grasp. It is not to be wondered at, then, that there have been many suggestions of its application to housework,[2] but there is thus far no record of the practical results when the stop-watch, the chronocycle-

[1] Frank C. Heard, "Turning Out More Work by Resting," *Factory*, July, 1912.

[2] Frank B. Gilbreth, "Motion Study in the Household; Reducing the Cost of Work in Effort and Time," *Scientific American*, April 13, 1912, vol. 106, p. 328; Florence Cushing, "Shop Methods Applied to Household Administration," *Journal of Home Economics*, November, 1910, vol. 2, pp. 581–82; Marie Urie Watson, "Scientific Housecleaning," *Craftsman*, December, 1912, vol. 23, pp. 353–55; "Laboratory Motion Study"; an editorial; *Engineering and Mining Journal*, February 17, 1912, vol. 93, p. 344.

graph, and the motion model have been operated on the cook and the housemaid.[1]

The result of properly directed time and motion study is the standardization of methods and equipment to secure the largest output in the minimum time with no material increase of effort.

Several good accounts of the effects of motion study have been published.[2]

Once standardization is effected, the method is reduced in detail to writing in the form of an instruction card[3] which is given the operator as a guide to the accomplishment of the predetermined standard of production.

The multiplicity of data from which instruction cards are compiled must be reduced to such

[1] For an amusing and imaginative account of possibilities in this direction reference may be made to a series of stories about "Efficiency Edgar," which appeared in the *Saturday Evening Post* during 1916.

[2] Robert T. Kent, "Motion Study in the Box Shop," *Industrial Engineering*, August, 1913, vol. 13, pp. 325–30; "Motion Study for the Moveman," *ibid.*, March, 1913, vol. 13, pp. 99–102; Leo J. Cleary, "How Six Managers Saved Lost Motion," *Factory*, November, 1912, vol. 9, pp. 408–09, 432; N. E. Adamson, Jr., "Production Betterment by Time Studies," *Iron Age*, April 4, 1912, vol. 89, p. 835.

[3] These instruction cards are illustrated in the article by Mr. Hathaway on time study referred to above, and in the following: Mr. H. W. Reed's "Following a Fixed Schedule Under the Taylor System," *American Machinist*, vol. 35, p. 1020; and "Two Turret Lathe Instruction Cards," *ibid.*, vol. 36, p. 915. See also Mr. Frank B. Gilbreth's "The Instruction Card as a Part of the Taylor Plan of Management," *Industrial Engineering*, vol. 11, p. 380.

form that they can easily be made available. Particularly is this true in the case of the conditions affecting the most economical cutting of metal. The vast body of information on this subject, as given in such a work as Mr. Taylor's "Art of Cutting Metals,"[1] must, for practical purposes, be made handy for use by the instruction-card man. This is the purpose of the slide rules devised and described by Mr. Carl G. Barth.[2] Mr. Barth shows how the same methods by which slide rules for the solution of ordinary mathematical problems have been constructed, may be applied to the construction of slide rules for the solution of the more complicated mathematical problems involved in the determination of the proper speed, feed, and depth of cut for machine tools. Technical details of the results of these methods are given in a highly interesting series of articles by Mr. L. P. Alford.[3]

[1] *Transactions*, A.S.M.E., vol. 28, p. 31.

[2] "Slide Rules as Part of the Taylor System," *Transactions*, A.S.M.E., vol. 25, p. 49. See also L. Descroix, *Les règles et cercles à calcul de Fred W. Taylor et Carl G. Barth pour l'application du Système de Taylor dans l'atelier mécanique* (Dunot et Pinat, Paris, 1908); Fr. Selter, "Ueber einen Versuch mit dem Taylor-Kalkulationssystem in Deutschland," *Werkstattstechnik*, 1910, pp. 129–41; R. Poliakoff, "Charts for Taylor's Cutting Speeds and Feeds," *American Machinist*, November 26, 1914, vol. 41, pp. 935–36.

[3] "The Respeeding of Lathes," *American Machinist*, vol. 41, no. 23, p. 973; "The Respeeding of Machine Tools," *ibid.*,

In spite of the fact that standardization is so fundamental a feature of scientific management, not much of consequence has been written on the subject.[1] In an article by Mr. P. Ballard,[2] the movement is criticized as not scientific, because its standardization methods stand in the way of progress. This illustrates a common fallacy in the discussion of standardization as that term is used by the scientific managers. It must be understood that standardization in their sense does not mean standardization of product, which is the common

vol. 41, no. 24, pp. 1017–21; "Standard Boring-Bar Cutters, Gibs, and Keys," *ibid.*, vol. 41, no. 27, p. 1148; "Standardizing Lathe Tool Posts," *ibid.*, vol. 41, no. 25, p. 1062; "Standard Taper Sockets and Shanks," *ibid.*, vol. 41, no. 25, pp. 1112–15.

[1] The best available are in the articles by Mr. Charles Day, "Advanced Practice of Economical Metal Cutting," *Engineering Magazine*, vol. 27, p. 549; Keppele Hall, "The Standardization of Papers," *Paper*, January 19, 1916; Robert T. Kent, "Scientific Management in the Office," *Iron Age*, January 7, 1915, vol. 95, no. 1, p. 82; Carl Bennett Auel, "Standardization in the Factory," *Iron Age*, December 3, 1914, vol. 94, no. 23, p. 1280; and in a book by Mr. C. U. Carpenter, *Profit-Making Management.* (New York, 1908.) There is a brief but suggestive article by Mr. E. M. Wooley on "Scientific Management in the Office," *System*, vol. 20, p. 3, dealing with the standardization of office equipment and supplies, and a characteristic note by Mr. Frank E. Gilbreth on "The First Case of Standardization," *Transactions*, The Efficiency Society, vol. 1, p. 257, taking the shape of a brick as his example.

[2] "Scientific Management and Science," *Cassier's Magazine*, vol. 41, p. 425. See also Henry Harrison Suplee, "Some Basic Principles of Efficiency," *Cassier's Magazine*, September, 1912, vol. 42, pp. 233–38.

acceptance of the term, but the determination of the best material, equipment, and process discoverable at any given time and adherence to it until a better is found. So far from standing in the way of progress, this conception of standardization rather stimulates and aids more rapid improvement, for it makes possible substantial improvements on the solid basis of what is already known, instead of the laborious rediscovery of methods already worked out and even, perhaps, abandoned for good cause.

In the Taylor System, the term "routing" has two significations. Sometimes it refers to the physical lay-out of plants and the relationship of departments, — in this sense it is most completely treated by Mr. Charles Day; [1] more usually, however, it is concerned with the analysis of the sequence of operations on the work and the determination of the place and time for each operation and group of operations. On this latter, the most intricate feature of the system, little has been published outside of Mr. Taylor's *Shop Management*.[2]

[1] *Industrial Plants.* (New York, 1911.)

[2] The only references of consequence outside the books are the articles by Mr. H. L. Gantt, "The Mechanical Engineer and the Textile Industry," *Transactions*, A.S.M.E., vol. 32, p. 499; C. W. Adams, "Planning Work Ahead to Save Time," *Factory*, February, 1909; A. Wallichs, "Taylors Erfolg auf den

Another characteristic feature of the Taylor System is the extensive use of classification and mnemonic symbolization. A series of articles by the present writer points out the purposes and methods of classification and mnemonic symbolization and its application to the various functions of costs, administration, stores system, routing, and filing.[1]

The use of the mnemonic system for facilitating the finding of costs has been described in a brief article.[2]

Although the Taylor System has a distinctive type of cost accounting, its details have not been published. The first part of Mr. Holden

Gebiete der Fabrikorganization," *Stahl und Eisen*, 1912, no. 2, Düsseldorf; J. A. Furer, "Management in the Drafting-Room," *American Machinist*, April 25, 1912, vol. 36, pp. 662–65; H. C. Wight, "Routing Work by Schedule," *Factory*, May, 1912, vol. 8, p. 358.

[1] C. B. Thompson, "Giving a Business a Memory," *System*, vol. 22, p. 588; "Memory Tags for Business Facts," *ibid.*, vol. 23, p. 21; "Taking Factory Costs Apart," *ibid.*, p. 131; "Listing Stock to Index Wastes," *ibid.*, p. 260; "Keeping Tab on Finished Parts," *ibid.*, p. 386; "Right Filing and Easy Finding," *ibid.*, p. 586.

The only other article on the subject is a brief abstract of a paper by Mr. H. G. Benedict, "The Mnemonic Symbolizing of Stores under Scientific Management," *Industrial Engineering*, vol. 12, pp. 24, 69. Reference should be made to an early article by Oberlin Smith, "Naming and Symbolizing," *Engineering Magazine*, June, 1911, vol. 41, pp. 461–70, reprinted from *Transactions*, A.S.M.E., 1882.

[2] "A Mnemonic System for Distributing Labor Costs on Construction Work," *Industrial Engineering*, vol. 9, p. 328 (anonymous).

A. Evans's book [1] deals with the subject, but not exactly in the manner in which it is practiced by the Taylor group.[2]

In a recent book on factory costs some details of the Taylor System are indicated.[3] The best description of the Taylor methods for a machine shop is to be found in a book by Rudolph Seubert, referred to above.[4] Some details of the application of these methods to reinforced concrete work are given in an article by John S. Nicholl.[5] The general attitude of the Taylor group toward current cost-accounting methods is well indicated in the articles by H. L. Gantt.[6] A good example of the influence of

[1] *Cost Keeping and Scientific Management.* (New York, 1911.)

[2] Mr. A. Hamilton Church's, *The Proper Distribution of Expense Burden* (New York, 1908), and *Production Factors* (New York, 1910), describe a method arrived at by him quite independently, which has been used in part for some time by the Taylor group. There is a brief anonymous article on "Cost and Time Keeping Outfit of the Taylor System," *American Machinist*, vol. 29, p. 761, and another by Mr. Charles J. Simeon on "The Scientific Management of a Foundry," *Iron Trade Review*, vol. 50, p. 68, which deal with some of the mechanical details.

[3] C. B. Thompson, *How to Find Factory Costs.* (Chicago, A. W. Shaw Co., 1916.)

[4] *Aus der Praxis des Taylor-Systems.* (J. Springer, Berlin, 1914.)

[5] "Scientific Cost-Keeping Methods for Reinforced Concrete Work — The Field and Office System of the Aberthaw Construction Company," *Engineering Magazine*, January, 1913, vol. 44, pp. 511–25.

[6] "Non-Productive Labor — The Fallacy of Its Use as a Measure of Efficient Operation," *Engineering Magazine*, Jan-

scientific management on accounting methods is a recent book by E. T. Elbourne based on English practice.[1]

The Taylor method of administering a tool room is admirably described by Mr. R. T. Kent,[2] emphasizing the importance of standardization, classification, maintenance, and control. The administration of belting is discussed by Mr. F. W. Taylor.[3]

Attention has often been called to the fact that the second cardinal principle in Mr. Taylor's system, the scientific selection and training of employees, has received no systematic treatment at the hands of the Taylor group, at least so far as selection is concerned. Training is duly emphasized and illustrated by Mr. Gantt in his *Work, Wages, and Profits* referred to above. There are two good popular articles on the subject by Mr. E. M. Wooley, "The One Best Way," and "The Wanton Waste of Labor," referred to above.[4]

uary, 1915, p. 577; "The Misleading Effect of Wrong Standards," *Industrial Engineering*, May, 1913, vol. 13, p. 202; Editorial on Gantt's "Measuring Efficiency," *American Machinist*, vol. 41, no. 24, p. 1047.

[1] *Factory Administration and Accounts.* (Longmans, Green & Co., London, 1914.)

[2] "The Tool Room under Scientific Management," *Industrial Engineering*, vol. 9, p. 87.

[3] "Notes on Belting," *Transactions*, A.S.M.E., vol. 15, p. 204.

[4] See also Harry F. Porter, "Showing Unskilled Labor 'How,'" *Factory*, October, 1914, vol. 13, pp. 268, 311–14.

There has been some preliminary discussion of the application of scientific methods to the selection of employees, but it has been on the part of men influenced by, but as a rule not directly connected with, the movement. Professor Walter Dill Scott [1] has written interestingly on the subject, as has also Mr. R. J. Burke.[2] Mr. Gilbreth has suggested a simple plan for systematizing promotions.[3] A movement for the more intelligent guidance of youth in the selection of vocations has brought in its train a study, as yet rather superficial, of the requirements of various trades and professions. It is at least an excellent beginning in the right direction.[4]

The only thing I have found on the selection of employees by any one even remotely connected with scientific management is a pamphlet by Mr. Harrington Emerson,[5] and this is

[1] "Selection of Employees by Means of Quantitative Determinations," *Annals*, American Academy of Political and Social Science, vol. 65, p. 182, 1916.

[2] "Written Specifications for Hiring," *Annals*, American Academy of Political and Social Science, vol. 65, p. 176, 1916. See also "Labor Problems in Scientific Management," *Iron Age*, December 10, 1914, vol. 94, p. 1369 (anonymous).

[3] "The Three Position Plan of Promotion," *Annals*, American Academy of Political and Social Science, vol. 65, p. 289, 1916.

[4] Frank Parsons, *Choosing a Vocation*. (Boston, Houghton, Mifflin & Co., 1909.) Meyer Bloomfield, *Vocational Guidance of Youth*. (Boston, 1911.)

[5] *The Scientific Selection of Employees*. (The Emerson Company, New York.)

an argument for the application of a system of selection which can be characterized only as a refined and slightly modernized phrenology, described in a book by the originators, Dr. Katherine M. H. Blackford and Mr. Arthur Newcomb.[1]

It is evident from this survey that the literature dealing with the actual methods of applying scientific management, while still far from complete, is growing into a respectable volume. The slowness with which these details are made public is due to a number of factors, one among which is the natural reluctance of specialists to divulge the details of their profession, because of their apparently well-grounded fear that the attempt to describe methods which must be modified to meet a wide variety of contingencies must necessarily be inadequate and to a certain extent misleading, and that therefore it is safer not to attempt at all to describe them in writing. In view, however, of the rapid extension of scientific management to many varieties of industries, and the comparative scarcity of qualified "experts," it appears that the time is ripe for such an exposition of methods as may be immediately and directly useful to any manager of the requisite intelligence to sense their

[1] *The Job, the Man, the Boss.* (New York, 1914.)

place in the system and to apply them with the thoroughness and discretion necessary.

This criticism of meagerness does not apply to one of the principal methods of scientific management — the use of wages as an incentive. There is nothing new about such use of wages, but the method of the Taylor group is characteristically different. With them wages are not used primarily as an incentive to production but as an incentive to the acceptance of standardized conditions and training and the following of instructions. Increased production is the direct result not of the bonus or differential piece rate systems but of the utilization by the employee, in consideration of higher wages, of the improved methods, materials and equipment provided him by the management. This was the point, though it is not made very clear, in Mr. Taylor's paper on "A Piece-Rate System and Shop Management" referred to above, and it runs all through Mr. Gantt's *Work, Wages, and Profits*.[1]

[1] This is brought out a little better by Mr. Harrington Emerson in a paper on "A Rational Basis for Wages," *Transactions*, A.S.M.E., vol. 25, p. 868. Out of the mass of books and articles on this subject, the following are also suggested, not necessarily because they are written by members of the Taylor group, which few of them are, but because a study of them will help make clear the philosophy of the use of wage systems by that group. The following are comparative discussions of various methods of wage payment: Mr. S. E. Thompson's "The

5. The Personal Factor in Scientific Management

The apparently cold-blooded statements of Mr. Taylor in *Shop Management* and *The Principles of Scientific Management* in regard to his methods of training employees and the mathematical determination of the incentives which actuate their conduct have led to a considerable discussion of the treatment of the "human factor" by scientific management. Discussion is

Taylor Differential Piece Rate System," *Engineering Magazine*, vol. 20, p. 617; "Differential Piece Rates" (anonymous), *Engineering*, vol. 80, p. 413; Mr. Clive Hastings's "The Efficiency of the Worker and His Rate of Pay," *American Engineer and Railroad Journal*, vol. 81, p. 238; Mr. Harrington Emerson's "Different Plans of Paying Employees," *Iron Age*, vol. 82, p. 1150; and Mr. C. B. Thompson's "The Reason for a Payroll," *System*, vol. 22, p. 249, and "When Higher Wages Pay," *ibid.*, p. 339. See also Sanford E. Thompson, "Time-Study and Task Work," *Journal of Political Economy*, May, 1913, vol. 21, pp. 377–87; H. L. Gantt, "Equitable Labor Compensation and Maximum Output," *Cassier's Magazine*, vol. 25, pp. 540–45, April, 1904; C. J. Morrison, "Short-Sighted Methods in Dealing with Labor," *Engineering Magazine*, vol. 46, no. 4, pp. 566–70; J. T. Towlson, "A British View of Shop Efficiency," *American Machinist*, August 24, 1911, vol. 35, pp. 361. To get one's bearings in the discussion, the articles by Messrs. Towne, Halsey, and Rowan, referred to above, should be read, and the following: Mr. W. O. Walker's "The Value of Incentives," *American Machinist*, vol. 26, p. 996; and Mr. C. J. Morrison's "Piece Rates versus Bonus," *ibid.*, vol. 36, p. 178. Highly interesting in this connection are also Mr. Carroll D. Wright's *Profit-Sharing*, Bureau of Statistics of Labor, no. 15; and the *Report of the British Board of Trade on Profit Sharing and Labour Co-Partnership in the United Kingdom.* (London, 1912.)

usually based on the truisms that system cannot take the place of honesty and intelligence; that specialization can be carried too far; that driving is an undesirable feature of factory management; that the workmen should not be made into automata; that they should not be set working against each other's interests; that attention should not be centered exclusively upon men above the average of ability; that the factors of habit and prejudice should not be ignored; that no solution of economic problems is complete which ignores the problem of distribution; and that the desires and aspirations of the men toward self-government and democracy must be recognized. Most of these points are mentioned in the *Report of the House Committee on Labor appointed to investigate the Taylor and other Systems of Management*,[1] leading to the conclusion that no recommendations were necessary, presumably because the criticisms suggested did not apply to the Taylor System.

The importance of a consideration of the human problem is emphasized by Mr. William C. Redfield.[2] Mr. James M. Dodge, formerly chairman of the Link Belt Company, whose

[1] Government Printing Office, Washington, 1912.

[2] "The Moral Value of Scientific Management," *Atlantic Monthly*, vol. 110, p. 411.

recent death has deprived scientific management of one of its foremost advocates, and the workingmen in his extensive plant of one of their best friends, was always insisting on the importance of a just mental attitude toward the human factor.[1] Interesting and convincing illustrations of the practical application of this attitude are given by Mr. Feiss, the manager of a large clothing factory.[2]

The nature of the psychological problems involved and an indication of the method of approach to their solution are discussed at some length by Professor Hugo Münsterberg.[3] The significance of the work begun by Mr. Taylor and his associates as it appears to a psycholo-

[1] "Industrial Management," *Industrial Engineering*, August, 1913, vol. 13, pp. 330–32. See also F. G. Coburn, "Labor-Saving Management and the Present," *American Machinist*, vol. 40, no. 2, p. 78, and Robert T. Kent, "Enlisting the Foremen's Coöperation," *Industrial Engineering*, July, 1913, vol. 13, pp. 285–88.

[2] "Personal Relationship as a Basis of Scientific Management," *Annals*, American Academy of Political and Social Science, vol. 65, p. 27, 1916. See the review, "The Beginnings of a New Science," *Survey*, April 19, 1913, vol. 30, pp. 95–96.

[3] *Psychology and Industrial Efficiency*. (Boston, 1913.) See also Professor Münsterberg's interesting article, "Psychology and the Navy," *North American Review*, February, 1913, vol. 197, pp. 159–80; Gilbreth's *The Psychology of Management* (New York, Sturgis & Walton, 1914); and Horatio Willis Dresser's *Human Efficiency; A Psychological Study of Modern Problems* (New York, G. P. Putnam's Sons, 1912). The latter is a highly transcendental study of individual efficiency from a psychological standpoint.

gist is emphasized, and examples are given of the more refined methods by which the psychological laboratory may be made an aid in the discovery of principles for industrial application.[1]

In a remarkable book by Miss Josephine Goldmark,[2] there is a suggestion that, although scientific management has thus far avoided the pitfall of driving, there has not been the inten-

[1] The fear that scientific management is an effort to substitute a system for integrity and ability is voiced by Mr. F. J. Whiting in "The Personal Equation in Scientific Management," *Stone & Webster's Journal*, vol. 8, p. 411. The fear of over-specialization finds expression in an editorial in *Engineering* (London) on "Scientific Management," vol. 93, p. 289, and is apparently the point of an article by Dr. Luther H. Gulick on "The Human Element," *Transactions*, The Efficiency Society, vol. 1, p. 181, and of one by Mr. A. Hamilton Church on "Intensive Production and the Foreman," *American Machinist*, vol. 34, p. 830. The answer to these may be deduced from Mr. M. P. Higgins's "Intensified Production and its Influence upon the Worker," *Engineering Magazine*, vol. 20, p. 468; Mr. Frank H. Rose's "The Rise of Labor Through Labor-Saving Machinery," *ibid.*, vol. 27, p. 836; Mr. A. E. Outerbridge, Jr.'s "The Educational Influence of Machinery," *ibid.*, vol. 9, p. 225; "The Emancipation of Labor by Machinery," *ibid.*, p. 1012, and especially Frank B. and L. M. Gilbreth's "The Effect of Motion Study upon the Workers," *Annals*, American Academy of Political and Social Science, vol. 65, p. 272, 1916. The value of scientific management in finding the place to which the laborer is best fitted and in fitting the man perfectly to fill it is emphasized in an editorial in *Machinery*, "Helping a Man to Find His Place," vol. 18, p. 279; in Mr. David Van Alstyne's "Profitable Ethics," in *Technology and Industrial Efficiency*, p. 207 (New York, 1911); and in Mr. Harrington Emerson's "Ethics and Wages," *Outlook*, vol. 99, p. 682.

[2] *Fatigue and Efficiency.* (The Russell Sage Foundation. New York, 1912.)

sive and scientific study of fatigue which might reasonably be expected from the scientific attitude of the leaders in the movement. Mr. F. H. Dwight [1] insists that the bonus, as applied at the Bethlehem Steel Works, is but another method of driving. The completest answer to the criticism of practice, no matter what may be said in regard to the absence of a scientific study of fatigue, is made by Clark and Wyatt,[2] who give the results of an intensive investigation of the effect of the Taylor System on women employed under it. This inquiry, begun with the expectation of finding the science of driving reduced to practice, ended after exhaustive personal study in many plants in a complete exoneration of the Taylor-Gantt methods from this charge.[3] A study of the methods pursued in a scientific management plant will go still further to dispel this illusion.[4]

The criticism that scientific management

[1] "The Taylor System as a Machinist Sees It," *American Machinist*, vol. 34, p. 989.

[2] *Making Both Ends Meet.* (New York, 1911.) See especially chap. VIII.

[3] Other significant articles on the same subject are: "Scientific Management as viewed from the Workmen's Standpoint," *Industrial Engineering*, vol. 8, p. 377, and Mr. Wilfred Lewis's "F. W. Taylor and the Steel Mills," *American Machinist*, vol. 34, p. 655.

[4] Richard A. Feiss, "The Health Factor in Output," *Factory*, December, 1914, p. 399, vol. 13, no. 6.

suppresses the initiative and ambition of the workman is presented by Mr. Frank C. Hudson [1] and further discussed by Mr. Holden A. Evans,[2] and particularly and most effectively by Mr. Charles B. Going [3] who points out that one distinctive feature of the modern systems of management is the restoration of the individuality of the workman.

The complaint that the effect of the task and bonus method is to concentrate the efforts of each workman exclusively upon his own success and well-being, has not been dignified with a formal article, but is given expression occasionally in the hearings before the House Committee on Labor. It is pretty effectively answered in an article by Lieutenant E. D. K. Klyce,[4] which points out the absolute necessity of mutual helpfulness and coöperation in the Taylor System.

Mr. Taylor talks so much about the "first class man" and has emphasized so little his explanation that by the first class man he

[1] "The Machinist's Side of Taylorism," *American Machinist*, vol. 34, p. 773.

[2] "Effect of the Taylor System: What is to Become of the Mechanic?" *ibid.*, vol. 33, p. 1095.

[3] "The Efficiency of Labor," *Review of Reviews*, vol. 46, p. 329.

[4] "Scientific Management and the Moral Law," *Outlook*, vol. 99, p. 659.

means the man adapted to the job he is doing, that the supposition is only natural that this system aims at the selection of the best only and the elimination of the average and mediocre.[1]

The undue haste with which outside followers of scientific management have attempted to revolutionize the methods and habits of thought of workmen and employers has called forth impressive and valuable warnings from Mr. James Hartness.[2]

Mr. Gantt has given some excellent practical advice to managers as to the scope and nature of the qualifications they should possess, which is particularly applicable in case they are considering the development of scientific management in their plants.[3]

The relation of scientific management to

[1] Illustrations given by Mr. Taylor do unquestionably show the strongly selective effect of his method; but this should not be allowed to distract attention from the effect of systematic training on the development of average and mediocre into "first class" men. This misunderstanding underlies the criticism in Mr. John R. Godfrey's "Eliminating the Inefficient Man," *American Machinist*, vol. 34, p. 1232.

[2] "The Factor of Habit," *Transactions*, The Efficiency Society, vol. 1, p. 237. Still more effective is his book, *The Human Factor in Works Management.* (New York, 1912.)

[3] *Industrial Leadership.* (Yale University Press, 1916.) Reviewed by C. B. Thompson, *American Economic Review*, vol. 6, no. 2, p. 380, 1916. See also H. L. Gantt, "The Meeting of Minds in Engineering," *American Machinist*, vol. 41, no. 5, p. 212.

larger social problems is hinted at by Mr. Taylor in *The Principles of Scientific Management*, and the ultimate bearing of the application of the system to social welfare, through the reduction of the cost of production and the increase of the purchasing power of the consumer, is briefly suggested. Mr. Gilbreth points out the effect of motion study as an increase of national wealth.[1] Professor Nearing shows the relation between the cost of living and efficiency.[2] E. P. Howes gives an example (perhaps imaginative) of the general effect of efficient methods on wages, living conditions, and the civic aspect of the community.[3]

If it could be supposed that the tendencies inherent in the system would be allowed to work themselves out to their logical conclusions, social and economic consequences of a far-reaching nature would reasonably be expected. This possibility has raised unduly the hopes and enthusiasm of some of the advocates of the movement and has brought down upon it the criticism of those calmer individuals who

[1] "Motion Study as an Increase of National Wealth," *Annals*, American Academy of Political and Social Science, vol. 59, p. 96.

[2] "Efficiency Wage Standards," *Popular Science Monthly*, March, 1912, vol. 80, pp. 257–62.

[3] "Æsthetic Value of Efficiency," *Atlantic Monthly*, July, 1912, vol. 110, pp. 81–91.

realize, in the first place, that no economic tendency ever does or can work out to its logical conclusion, and, in the second place and particularly, that production and consumption are but a part of the entire economic problem.

A few exceptionally thoughtful articles criticizing scientific management from the social point of view have been written by European scholars on the basis of an academic knowledge of the movement. There is a friendly criticism discussing social advantages and possible objections by Wilhelm Kochmann.[1] Another excellent criticism is that by E. Lederer.[2] J. M. Lahy has written a keen criticism of some elements in the system pointing out particularly the comparative neglect of the element of fatigue.[3] A Spanish scholar, C. Montoliu, has reviewed most of the European and some of the American literature on the subject.[4]

[1] "Das Taylorsystem und seine volkswirtschaftliche Bedeutung," *Archiv für Sozialwissenschaft und Sozialpolitik*, March, 1914, vol. 38, p. 391.

[2] "Die öconomische und sozialpolitische Bedeutung des Taylorsystems," *Archiv für Sozialwissenschaft und Sozialpolitik*, May, 1914, vol. 38, p. 769.

[3] "La Méthode Taylor peut-elle déterminer une Organization scientifique du Travail," *Grande Revue*, September 25, 1913, p. 345.

[4] "El Sistema de Taylor y Su Critica," *Estudio*. (1915. Barcelona.)

Those who are looking for a panacea for social ills and who suppose that scientific management was offered as such a panacea are keen to point out that it does not deal finally with the problem of distribution. Professor Edward D. Jones [1] was acute enough to see that Taylor's work developed a principle of distributive justice, — namely, the rewarding of the individual for his individual performance, — and was not disappointed that it did not go farther in this matter than it professed to go. Mr. Dexter S. Kimball, in the article mentioned above, Mr. Ralph E. Flanders,[2] and Mr. W. H. Herschel [3] have pointed out, with the air of making a discovery, that the Taylor System does not solve the problem of distribution. Mr. Louis Duchey [4] hails the failure of the system to solve the system of distribution and its one-sided emphasis on production as the force which will do most to intensify class consciousness and hasten the destruction of capitalism.

[1] "Review of Taylor's 'Shop Management,'" *American Economic Review*, vol. 2, p. 369.

[2] "Scientific Management from a Social and Economic Standpoint," *Machinery*, vol. 18, p. 764.

[3] "Social Philosophy and the Taylor System — Will the Ultimate Result of the Taylor System be Beneficial?" *Engineering News* (London), vol. 65, p. 577.

[4] "Scientific Business Management. What is it? What Effect will it have on the Revolutionary Movement?" *International Socialist Review*, vol. 11, p. 628.

The relation of scientific management to the unemployment problem has received attention in two articles by M. L. Cooke [1] and one by Mr. C. E. Reitzel.[2]

The test of democracy has of course been applied to this movement. That a clear definition of democracy as applied in industry is sadly needed has been indicated in an excellent article by President Hopkins.[3] Mr. Meyer Bloomfield [4] points out, apparently with some misgiving, that the loyalty of the employee must be secured by keeping the enterprise democratic; while Mr. Paul U. Kellogg,[5] one of the editors of the *Survey*, is more specific to the effect that this new industrial force must be socialized. Mr. H. B. Drury is still more specific when he demands that scientific management must recognize the function of free play

[1] "Scientific Management as a Solution of the Unemployment Problem," *Annals*, American Academy of Political and Social Science, vol. 61, 1915. "Casual and Chronic Unemployment," *Annals*, American Academy of Political and Social Science, vol. 59, p. 194. Reviewed in *La Revue Électrique*, May 19, 1916.

[2] "Industrial Output and Social Efficiency," *Annals*, American Academy of Political and Social Science, vol. 59, p. 125.

[3] Ernest Martin Hopkins, "Democracy and Industry," *Annals*, American Academy of Political and Social Science, vol. 65, p. 57, 1916.

[4] "Scientific Management: Coöperative or One-Sided," *Survey*, vol. 28, p. 312.

[5] "A National Hearing for Scientific Management," *Survey*, vol. 25, p. 409.

from below.[1] Mr. Frank T. Carlton [2] goes still farther by pointing out how the movement should be made democratic by giving the workman a voice in the determination of the conditions and the rate of bonus under which he will work. Scant agreement with this conception can be found in the writings of Taylor. His attitude and that of men of similar training and experience [3] is that the employee has no right to control or participate in the management of the establishment. If this is strictly true, there is obviously in scientific management no place for recognition of trade-unionism, the collective bargain, and other mutually agreed arrangements.

6. Scientific Management and Organized Labor

The attitude of Mr. Taylor and his immediate followers toward labor organization is difficult to determine from their writings. Thus Taylor says, in *Shop Management:* "There is no reason why labor unions should not be so con-

[1] "Democracy as a Factor in Industrial Efficiency," *Annals*, American Academy of Political and Social Science, vol. 65, p. 15, 1916.

[2] "Scientific Management and the Wage-Earner," *Journal of Political Economy*, vol. 20, p. 834.

[3] "The Human Element in Scientific Management," by Messrs. H. R. Towne, Oberlin Smith, John Calder, A. C. Higgins, and A. Falkenau, *Iron Age*, vol. 89, p. 912.

stituted as to be a great help both to employers and men. Unfortunately, as they now exist they are in many, if not most, cases a hinderance to the prosperity of both." He acknowledges the current obligation of society to organized labor for increased safety, shorter hours and in some cases better working conditions. It appears to be his belief, however, that where scientific management is practiced fully and completely, the workingman is automatically protected by the self-interest of his employer, owing to the fact that the administration of the task and bonus is dependent on the willing coöperation of the man and the maintenance of his efficiency through the complete standardization of conditions. Nowhere is he very clear, however, on the practicability of the collective bargain in a scientifically managed régime; while on the other hand he is definite and forceful in his denunciation of some of the methods of unionism, particularly the restriction of output.

Whatever Mr. Taylor's real view of the matter may be, the fact is that the labor unions have taken a violent antipathy to scientific management.[1] This is at least partly due to

[1] The best of the articles ont his subject are the following: E. Pouget, *L'Organisation du surmenage* (le système Taylor). (Paris: Rivière, 1913.) A biting criticism of the entire move-

what one writer calls Mr. Taylor's "unfortunate and tactless statements"[1] in regard to labor. There are, however, other and more fundamental reasons for this lack of agreement. An anonymous writer in the *Electrical Railway Journal*[2] points out that specialization, through its easy training of the unskilled, strikes at the heart of labor unionism as at present organized. An editorial in the *World's Work*[3] prophesies that "the foolish unions will oppose it as they opposed the introduction of machinery, and lose." *The Century Magazine*[4] observes that the labor union insists upon "equality." Mr. G. F. Stratton, in the *Outlook*,[5] finds the point of divergence in the fact

ment by Angelo Mariotti, *Il Sistema Taylor e l'organizzazione scientifica*, don Marzio, June 20, 1914, who reviews briefly German and French Syndicalist criticism. Howard T. Lewis, "The Problem of the Efficiency of Labor," *Popular Science Monthly*, vol. 82, pp. 153–62, February, 1913. Harlow S. Person and others, "Industrial Efficiency and the Interests of Labor," *American Economic Review*, March, 1912, supplement, vol. 2, pp. 117–30, and two highly optimistic articles by H. Godfrey: "Attitude of Labor towards Scientific Management," *Annals*, American Academy of Political and Social Science, 1912, vol. 44, p. 59, and *Increased Efficiency*, Brotherhood of Railway Mechanics, Convention Number, 1912.

[1] Mr. C. H. Stilson, "Letter on Scientific Management," *American Machinist*, vol. 35, p. 175.

[2] "Scope of Scientific Management," vol. 41, p. 451.

[3] "Scientific Management and the Labor Unions," vol. 22, p. 14311.

[4] "Taking Ambition out of the Workman," vol. 82, p. 462.

[5] "Ca-Canny and Speeding Up," vol. 99, p. 120.

that the unions set a minimum wage which the employers treat as a maximum. The chief reason, however, appears to be found in the policy of restriction of output. The belief that restriction of output is a confirmed labor-union policy is apparently borne out by the Eleventh Special Report of the United States Commissioner of Labor, on the "Regulation and Restriction of Output,"[1] — one of those Government reports which, like the Report on the Hearings before the Labor Committee investigating the Taylor System and the Report of the Civilian Expert Board on Industrial Management of United States Navy Yards, which favored the application of scientific management to the navy yards, was suddenly and mysteriously "out of print" almost immediately after publication.

As was seen in an earlier section, railroads in their controversy with the scientific managers have not hesitated to point to the opposition of the labor unions as one of the reasons for the impracticability of the application of the system to their industry, and to substantiate their argument, as in an article in the *Iron Age*,[2] by quoting the restrictive laws of such an or-

[1] Government Printing Office, Washington, 1904.

[2] "Railroad Efficiency and the Labor Unions," vol. 87, p. 476.

ganization as the International Iron Molders' Union.[1]

The published expressions of labor-union leaders referring directly to scientific management have ranged from an attitude of suspended judgment to one of bitter antipathy. Mr. John Golden, of the Textile Workers,[2] is non-committal, but suspicious. Mr. J. P. Frey, of the Iron Molders,[3] is sure that it is at least unscientific. Mr. James Duncan, vice-president of the American Federation of Labor,[4] conveys the impression that scientific management is the summation of all the evils of all the generations of oppression of the workingman. Yet this opinion is mild compared with that of the before-mentioned Mr. James O'Connell (formerly a member of the National Commission on Industrial Relations, which also "inves-

[1] Other interesting articles on the attitude of the unions toward premium plans are those by Mr. H. M. Norris, "Actual Experience with the Premium Plan," *Engineering Magazine*, vol. 18, pp. 572, 689, and Mr. James O'Connell, "Piece Work not Necessary for Best Results in the Machine Shop," *ibid.*, vol. 19, p. 373.

[2] "The Attitude of Organized Labor," *Journal of Accountancy*, vol. 12, p. 189.

[3] "Relation of Scientific Management to Labor," *Iron Trade Review*, vol. 52, p. 917, and in *Journal of Political Economy*, May, 1913, vol. 21, pp. 400–11, and *American Federationist*, April, 1913, vol. 20, pp. 296–302. Also Enrico Alfredo Masino, *L'Ostilita degli Operai e delle loro Organizazzione.* (Rome, 1913.)

[4] "Efficiency," *Journal of Accountancy*, vol. 12, p. 26.

tigated" scientific management) in an official letter to the Machinists' Unions, in which he says: "Wherever this system has been tried it has resulted either in labor trouble and failure to install the system, or it has destroyed the labor organization and reduced the men to virtual slavery, and low wages, and has engendered such an air of suspicion among the men that each man regards every other man as a possible traitor and spy. . . . We trust that you will be impressed with the importance of this matter, and will see the impending danger. Act quickly." There is a bitter and flippant attack by John Mitchell, of the Mine Workers, in a book published by him in 1913.[1] The published articles in newspapers on this subject are very numerous; they are not listed here as they are variations on the same theme.

The Machinists' Union and after it the American Federation of Labor have made the application of scientific management in government arsenals, particularly in the arsenal at Watertown, Massachusetts, the object of their official attack. Reference has already been made to the report of the committee appointed

[1] *The Wage-Earner and his Problems*, p. 59. Washington, D.C., Ridsdale, 1913. See also Samuel Gompers, "The 'Efficiency' Scape-Goat," *American Federationist*, July, 1913, vol. 20, pp. 531–33.

to investigate the trouble there in 1911. In the 1913 Report of the Chief of Ordnance,[1] General Crozier deals with the petition of the Watertown employees referred to above. This petition was evidently the first gun in the campaign inaugurated by the American Federation of Labor at their 1913 convention in Seattle, at which they decided officially to fight the extension of the Taylor System.[2]

The best articles counseling the unions to take a saner point of view are those by Mr. Louis D. Brandeis,[3] in which he argues that scientific management is but the application of thought and knowledge to industry, that increased efficiency and production operate in the interest of the workingman, and that its progress and ultimate success are inevitable. The

[1] *Report of the Chief of Ordnance, 1913*. (Government Printing Office, Washington.) See also "Labor Efficiency," *Outlook*, November 1, 1913, vol. 105, pp. 467–68.

[2] American Federation of Labor, *Report of Proceedings*, 33d Annual Convention, held at Seattle, Washington, November 10–22, 1913. Interesting articles bearing on this subject are those by Mr. Max H. C. Brombacher, "The Rock Island Arsenal Labor Trouble," *Iron Age*, vol. 89, p. 476; by Lieutenant-Colonel W. S. Peirce, on "Government Shop Management," *ibid.*, p. 476; and an article, "Scientific Management at United States Arsenals," *ibid.*, vol. 88, p. 1022, which includes a statement of former Secretary of War Stimson.

[3] "The New Conception of Industrial Efficiency," *Journal of Accountancy*, vol. 12, p. 35, and "Organized Labor and Efficiency," *Survey*, vol. 26, p. 148. See also chapters in Brandeis's *Business — A Profession*. (Boston: Small, Maynard & Co., 1914.)

same thought is expressed by Mr. Harrington Emerson.[1]

On the other hand, scientific managers have been freely advised to recognize more fully the necessity of coöperation with the unions. This is the attitude of Mr. John R. Commons,[2] who points out that the bonus system implies an individual bargain with the workman, and therefore strikes at the very existence of the union, unless its terms can be made the subject of a collective bargain; of Dr. John H. Gray,[3] and of the present writer,[4] who holds that the labor unions may and should assist in the determination of the standardized conditions and of a day's work and its attainment, and that the existence of the unions is and will continue to be necessary to maintain an adequate minimum wage.

[1] "The Fundamental Truth of Scientific Management," *Journal of Accountancy*, vol. 12, p. 17. See also Charles T. Root, "Efficiency and Lower Prices," *Iron Age*, December 15, 1910, vol. 86, pp. 1344–45, and "Labor Unions and Efficiency," *Nation*, April 6, 1911, vol. 92, p. 334.

[2] "Organized Labor's Attitude Towards Industrial Efficiency," *American Economic Review*, vol. 1, p. 463.

[3] "How Efficiency Should Benefit the Employer, the Employee, and the Public," *Transactions*, The Efficiency Society, vol. 1, p. 67.

[4] C. B. Thompson, "The Relation of Scientific Management to the Wage Problem," *Journal of Political Economy*, vol. 21, p. 630.

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